OCTOBER, 1956
No. 217

ASTM Bulletin

OUTSTANDING WEST COAST MEETING

American Society for Testing Materials

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IN THE SOCIETY

GENERAL NEWS NOTES

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

Number 217 **October 1956**

Unfinished Business . . .

Outstanding West Coast Meeting Sessions Chart Course of Continued Research in Properties of Materials

ASTM's Biggest Technical Program—200 papers in 43 Sessions plus Industry Luncheons—Registration 1537

"Unfinished Business" may seem a strange way to characterize a meeting that was in every way such an outstanding success, but in a sense this is of itself an indication of its success. The papers and discussion were of such value and interest so sustained that the meeting will not be considered complete until the ensuing publications are all available. But apart from this, there was the repeated expression in the sessions of more work needing to be done, more opportunity needed to discuss the many vital problems in properties of materials. Many of the authors concluded their presentations on the note that their purpose will have been served if other investigators are prompted to undertake work along the same lines. Some specifically recommended organized work to be initiated by the Society to take care of some outstanding need. It is expected that much will come of this meeting. In the meantime the record is briefed on the following pages.

As President R. A. Schatzel said at the opening session in Los Angeles on September 17, this was "another meeting of ASTM to carry out its usual functions of communications between producer and consumer and to form a meeting ground for commercial transactions on a fair and equitable basis."

Complimenting the Committee on Arrangements on their excellent planning for the meeting the ASTM President predicted a most successful program—"The diversity of the papers themselves at this meeting . . . is some indication of the board coverage and interest that ASTM itself has in materials and methods of testing.

"I believe all of you realize the functions that ASTM does perform in providing a forum for the exchange of opinion, data, and development of knowledge of materials and methods. It has done this for fifty years on a purely voluntary basis; so over that time it has attained the distinction which, I believe, is unrivaled in any other country in the world. It has both a national and international reputation. Out of these various discussions, forums, symposiums, advancing new knowledge—and formulating old and established practices into standards which takes them out of the realm of discussion and puts them to use—we have brought a service to industry in our country, and I am sure it is going to be advanced here."

Plant Visits

The Southern California industries made the ASTM members most welcome and a number of plants arranged for the members to make inspection tours. The Committee on Arrangements is given much credit for the manner in which this feature of the meeting was handled and was sincerely appreciated as was evidenced by the number who took advantage of this opportunity.

Ladies Entertainment

The local Committee on Arrangements had gone to considerable pains to arrange a most entertaining program of trips and other events for the ladies. Their efforts, no doubt, contributed no little in encouraging the attendance of quite a number of ladies from the East. Many of the members were accompanied by their families. The ladies' registration was 147, which compares very favorably with an Annual Meeting in the East.

Technical Sessions

Aircraft industry heavily represented in papers, discussions, and emphasis—several sessions stress problems of special concern to West Coast area such as seismic shock, water, wood resources

SYMPOSIUM ON RADIATION EFFECTS ON MATERIALS

ASTM's first symposium in important new field heard by large audience

The first full-dress symposium covering radiation effects on materials was presented before an ASTM audience of 250. It was sponsored by the Subcommittee on Radiation Effects of the Atomic Industrial Forum and ASTM Committee E-10 on Radioactive Isotopes and Radiation Effects. The next symposium is scheduled for the 1957 Annual Meeting of ASTM in June at Atlantic City, N. J.

A large degree of credit for organizing these presentations is due D. O. Leeser of the Atomic Power Development Associates. Organizations represented by the 13 papers included Brookhaven National Laboratory, Battelle Memorial Inst., Oak Ridge National Laboratory, Westinghouse Electric Corp., North American Aviation, Argonne National Laboratory, Sylvania Electric Products, E. I. du Pont de Nemours & Co., and Massachusetts Institute of Technology. A film "Hands Across the Atom" was also shown by the Hanford Works of the General Electric Co., illustrating the special measures and techniques that need to be followed in carrying out testing on irradiated materials.

Data on testing materials in many of the types of reactors in existence were enthusiastically received, and discussion periods were lively and rewarding. Full credit for catalyzing the discussion is due the chairmen of the sessions: C. C. Woolsey, North American Aviation; D. O. Leeser, G. D. Calkins, Battelle Memorial Inst.; J. B. Austin, U. S. Steel Corp.

RADIOACTIVE ISOTOPES

Audience rates these as an outstanding group of papers in this field

In the opinion of many listeners these papers were the most interesting and instructive group ever heard on the subject. Sponsored by ASTM Committee E-10 on Radioactive Isotopes, both laboratory and industrial scale uses of radioisotopes were described in papers from Rock Island Arsenal, Douglas Aircraft Co., University of Michigan, Westinghouse Research Laboratories, Shell Development Co., Tracerlab, Nuclear Instrument and Control Co., and the Michigan State Highway Department.

The subjects included electroplating and metal preservation studies, rubber deterioration, autoradiography, soil removal and detergency, refinery scale applications, industrial activation analysis; determination of naphthalene in coal tar, thickness and concentration gaging, and traffic-paint-wear studies.

Three papers on radiation effects directly reflect Committee E-10's entry into this field. One Oak Ridge National Laboratory paper discussed the question, "Will ASTM Specifications be Influenced by Radiation Effects in Metals," and another from Oak Ridge gave some data on the problem of establishing specifications for organic materials. The problem of radiation dosimetry was very ably covered by a paper from the General Electric Co., ANP Project.

With C. E. Crompton, National Lead Co. of Ohio, and G. D. Calkins, Battelle Memorial Inst., acting as chairmen of the two sessions, very informative discussion on all twelve papers was drawn from the audience. Mr. Crompton was also directly or indirectly responsible for arranging the presentation of all the papers as symposium chairman.

TITANIUM

Aircraft and related industries provide most of the papers and discussion

The first session, opened by J. R. Long of the Harvey Machine Co. who was also chairman of the symposium committee, was heard by an audience of 125.

Data on thermal stability were presented by Schwartzberg, Williams, and Jaffee of Battelle Memorial Inst. Also from Battelle came two papers by Holden, Ogden, and Jaffee on effect of temperature on elongation and on effect of composition and annealing on thermal stability.

Sherman, Parris, and Kessler, Titanium Metals Co., discussed elevated temperature properties of an alloy and L. B. Stark, North American Aviation Inc., described properties and fabrication characteristics of wrought titanium.

Extensive discussion of the papers included questions and further information from representatives of California Institute of Technology, North American Aviation, Lockheed Aircraft, Western Gear, Sandia Corp., Armour Research Foundation, and Douglas Aircraft.

The second session was devoted to the presentation and discussion of five papers dealing with various aspects of physical testing of titanium and titanium alloys. These included a paper on the use of statistical techniques in connection with maintaining quality control by C. R. Smith, Mallory-Sharon Titanium Corp. Much progress has been made in the development of tests applicable to titanium, and the discussion indicated the importance of this subject.

It was evident from the four papers in the third session presided over by F. T. Wood, Jr., Douglas Aircraft Co., that considerable progress had been made not only in improving ease of handling the complicated equipment that seems necessary for certain chemical analyses of titanium, particularly in determining oxygen, but that accuracy, likewise, is coming to be more nearly what the analysts desire.

In two papers from Electro Metallurgical Co., R. M. Fowler described oxygen analysis; R. L. Folkman and M. Schussler the development of samples and testing techniques for titanium sheet.

C. Blake and L. T. Eck, Titanium Metal Co. of America, covered titanium sponge evaluation and, finally, the Bureau of Mines' Don Baker contributed results of extensive work on the important Brinell hardness testing problems. Hardness testing is of special concern since it is considered a sort of quality-control test and from it production men can determine just how their product is running. In commenting on determining gaseous elements of titanium, Fowler said that there is little hope that the emission spectroscopist can handle this determination although the simple mass spectrograph might be developed usefully; sets of vacuum fusion apparatus are coming into increasing use. However, simpler and more reliable apparatus approaches are needed. As the production of refractory metals increases, routine determinations of gaseous elements may become as nec-

PRESIDENT'S LUNCHEON

General Irvine,—"Super Materials for Super Performance"

The highlight of the West Coast meeting was the President's Luncheon at which the Air Force's Lt. Gen. Clarence S. Irvine, Deputy Chief of Staff (Materiel), was the principal speaker. The President, in welcoming the members and others in attendance spoke very interestingly on the subjcct "Where Do We Go from Here?" which tied in very appropriately with the General's talk.

In his address, "Super Materials for Super Performance," General Irvine stated his primary concern was that industry should be alert to the development of the needed materials to carry out plans for the missiles and other equipment that are now in prospect. Much research is needed and it is most desirable that this work be carried on by industry, rather than to rely on Government-sponsored research. With this is needed properly trained personnel and at the present time there is a great shortage in youth training. In contrast, the General cited developments that are taking place elsewhere. America cannot afford to relax in any way in its scientific endeavors. It is expected that Gen. Irvine's complete address will appear in a later issue of the BULLETIN. President Schatzel's address appears on page 21 of this issue.

The luncheon to which many industrialists in the area had been invited was very well attended, with close to 400 present.

essary as the rapid carbon-content determinations of steel.

In his introductory remarks to this session, ASTM Director F. L. LaQue, vice-president and manager, Development and Research Div., The International Nickel Co., Inc. pointed out that this symposium was, in essence, one of ASTM's research contributions—by which through presentation, discussion, and publication of data, the work of hundreds of technologists is benefited.

FERROUS METALS

Shotpeening and presetting techniques allow higher stresses and weight reductions

Much interest was shown in the four papers comprising this session. Two dealt with shotpeening and other methods of increasing strength and fatigue life of steel. N. E. Hendrickson, Rheem Automotive Co., noted that shotpeening and presetting techniques are being used more and more for increasing the fatigue life of highly stressed parts such as springs, etc. With these techniques higher stresses are allowable and remarkable weight reductions have been noted.

H. O. Fuchs, Metal Improvement Co., described shotpeening effects and specifications. He stated that the standard Almen test strip and gage is a good tool for control of the process and can also be used as a good measure of the peening effect on medium hard steel. However, because the test does not measure peening effect on aluminum alloys or on very hard steel and soft materials, shot size and shot material should be specified in addition to intensity. By measuring the arc height of a special test strip or simple diameter, peening effect can be correlated with an Almen intensity reading.

A. E. Flanigan and E. U. Lee, University of California, presented a determination of the rates of isothermal evolution of hydrogen from welds. This was carried out in an attempt to uncover the mechanism for the immunization of weld metal to micro-cracking—still a very involved and difficult area of study.

J. Dubuc and G. Welter, École Polytechnique, and V. N. Krivobok, International Nickel Co., presented the studies of type 301 stainless steel columns which have been carried out at the École Polytechnique in Montreal. Apparently, theoretical values of buckling stress given by the Watter-Lincoln graphs agree well, at least for slenderness ratios above 40, with experimental values, but with ratios below about 40, buckling of the wide faces occurred for stresses near to those predicted by Watter and Lincoln. It was noted that a mild heat treatment at 550 F for this grade increased the elastic limit very much, making the stress-strain diagram linear up to much higher stresses and decreasing rolling direction influence.

J. O. Almen, pioneer in the field of shotpeening, participated actively in the discussion, reiterating his strong belief that some kind of peening, even hammer peening on the welds of some of the vessels which had cracked, might have helped to prevent these.

NON-FERROUS METALS

Young's modulus—beryllium copper strip—sea-water corrosion resistance of aluminum

The three papers and the condensed version of the 1956 Gillett Lecture which comprised the Non-Ferrous Metals Session dealt with interesting problems in this field such as determination of Young's modulus under relaxation, the properties of beryllium copper strip, and the use of pit and depth measurements to determine corrosion resistance of aluminum in sea water. Henry Burghoff, metallurgist at Chase Brass & Copper Co., presented D. K. Crampton's 1956 Gillett Lecture, "Structural Chemistry and Metallurgy of Copper." (This lecture is now available in separate form and will also appear in the 1956 *Proceedings*.)

Rather clever equipment for determining Young's modulus of magnesium alloys was described by Raymond Fenn of Dow Chemical Co. Accurate values are desired of this modulus because of use at higher temperatures and the need for its use in buckling and stiffness criteria. Dow described five methods of gripping the specimens and the effect of each on the modulus.

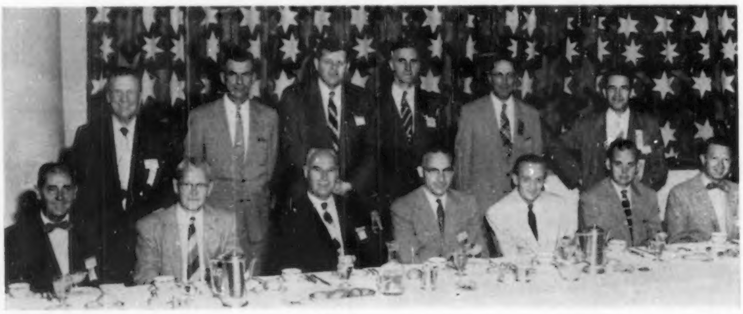
By making a comparison of the mean square-root depth, the standard deviation in frequency of pitting determined by statistical consideration of penetrometer measurements of the pits present, makes it possible to determine the resistance of aluminum to pitting corrosion in sea water. Details were given by T. J. Summerson, M. J. Pryor, D. S. Keir, and R. J. Hogan, Kaiser Aluminum & Chemical Corp.

PETROLEUM—Seated, l. to r.: ASTM Senior Vice-President R. T. Kropf, v.p. and director of research, Belding Heminway Co., Inc.; ASTM Exec. Sec'y R. J. Painter; R. L. Minckler, pres., General Petroleum Co.; ASTM Director R. C. Alden, chairman, Research Planning Board, Phillips Petroleum Co.; Guest Speaker H. G. Vesper, v.p., Standard Oil Co. of Calif.; Toastmaster W. T. Gunn, director, Div. of Refining, American Petroleum Inst. and Sec'y, Committee D-2; (standing) President R. A. Schatzel; W. L. Stewart, Jr., exec. v.p., Union Oil Co.; C. E. Emmons of the West Coast Committee, retired; D. E. Day, v.p., Richfield Oil Corp.; E. R. Millet, Jr., sec'y, California Natural Gasoline Ass'n.; Richard Sneddon, manager, Los Angeles Petroleum Club; P. J. Smith, ASTM Standards Editor.

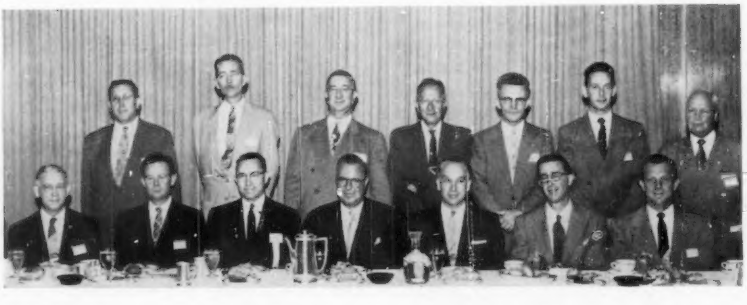
Industry Luncheons

The seven Industry Luncheons were a rewarding and well-received feature of the Los Angeles Meeting. In general, they were quite well attended, the attendance ranging from 80 to 231. The list of these Industry Luncheons, together with the principal speakers at each, follows:

Petroleum	Howard G. Vesper, vice-president, Standard Oil Co. of California.
Soils	K. B. Woods, head, School of Civil Engineering, Purdue University.
Wood	O. Harry Schrader, Jr., general manager, U. S. Plywood Corp.
Railroad	J. W. Corbett, vice-president (systems operations), Southern Pacific Co.
Industrial Water	Claude K. Rice, coordinator, Gulf Oil Corp.
Cement and Concrete	A. Allan Bates, vice-president, research and development, Portland Cement Assn.
Paint	Clyde L. Smith, president, Federation of Paint & Varnish Production Clubs, and president, Vi-Cly Industries, Inc.



WOOD—Seated, l. to r.: ASTM Prod. Ed. G. A. Wilson; John Fies, National Lumber Manufacturers Assn.; Frank Hanrahan, exec. v.p., American Institute of Timber Construction; F. E. Dickinson, director, Forest Products Lab., University of California; L. J. Carr, past pres., Forest Products Research Society; G. M. Jemison, director, California Forest & Range Experiment Station; C. M. Herd, pres., Structural Engineers Assn. of California; (standing) ASTM Past Pres. L. J. Markwardt, asst. director, U. S. Forest Prods. Lab.; Guest Speaker, O. H. Schrader, Jr., gen. mgr., U. S. Plywood Corp.; T. K. May, director of technical service, West Coast Lumbermen's Assn.; C. P. Berolzheimer, v.p., California Cedar Products Co.; F. B. Doolittle, elec. engr., Southern Calif. Edison Co.; and ASTM Assoc. Exec. Secy. R. E. Hess.



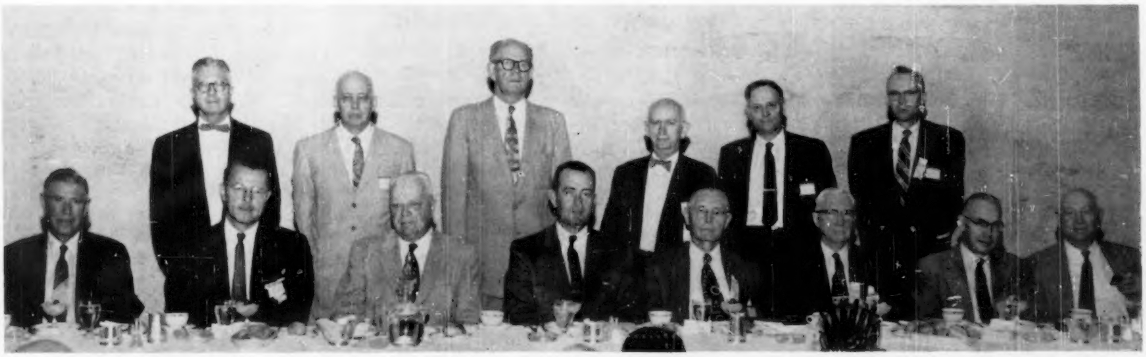
PAINT—Standing, l. to r.: P. J. Smith, ASTM Standards Ed.; W. A. Gloger, National Lead Co.; R. B. Stringfield, consulting chem. engr., J. W. Anderson, Bradley Paint Co.; L. A. O'Leary, head, Chemical Engineering and Research Dept., W. P. Fuller & Co.; C. W. Finegan, pres.-elect, Los Angeles Paint and Varnish Production Club; G. J. Grieve, mgr., transportation sales, Pacific Paint and Varnish Co.; (seated) C. F. Pickett; Guest Speaker, Clyde L. Smith, pres., Federation of Paint and Varnish Production Clubs; ASTM Director J. C. Moore, director, Technical Div., National Paint, Varnish & Lacquer Assn.; R. E. Alexander, pres., Los Angeles Paint, Varnish, and Lacquer Assn.; W. H. Fellows, exec. v.p., Old Colony Paint and Chemical Co.; F. G. Fox, dean, Evening Div., Los Angeles City College; and L. L. Whiteneck, v.p., Plicoflex, Inc.

SOILS—l. to r.: ASTM Asst. Secy. F. F. Van Atta; B. A. Vallerga, managing engr., Pacific Coast Region, The Asphalt Institute; L. Leroy Crandall, consulting foundation engr.; G. E. Brandow, partner, Brandow & Johnston; D. L. Narver, chm. of board, Holmer, Narver, Inc.; J. V. Spielman, supervising engr. of dams, Calif. Dept. of Water Resources; W. G. Holtz, head, Earth Materials Lab., U. S. Bureau of Reclamation, Denver Federal Center; R. W. Binder, chief engr., Bethlehem Pacific Coast Steel Corp.; John A. Bishop, director, Soils & Pavement Div. Research Dept., U.S.N. Civil Engineering Research & Evaluation Lab.; F. J. Converse, prof. of soil mechanics, California Institute of Tech-

CEMENT AND CONCRETE—Standing, l. to r.: Exec. Secy. R. J. Painter; ASTM Director A. A. Bates, v.p. of research and development, Portland Cement Assn.; Honorary Member, W. C. Hanna, v.p., California Portland Cement Co.; E. T. Telford, asst. state hwy. engr., California Division of Highways; W. H. Price, head, Engineering Labs., United States Bureau of Reclamation; N. J. Redmond, pres., Blue Diamond Corp.; M. A. Swayze, director of research, Lone Star Cement Corp.; Cris Dobbins, pres., Ideal Cement Co.; Adm. Cushing Phillips, pres., Los Angeles Board of Public Works; E. E. Duque, pres., California Portland Cement Co.; (seated) R. J. Mitchell, pres., Consolidated Rock Products Co.; E. E. Trefethen, exec. v.p., Kaiser Industries; R. E. Davis, director emeritus, Engineering Materials Lab., Univ. of California; W. W. Mein, Jr., pres., Calaveras Cement Co.; ASTM Director R. R. Litehiser, chief engr., Ohio State Highway Testing Lab., Ohio State Univ.; W. A. Marsh, gen. mgr., Permanente Cement Co., and v.p., Kaiser Industries; Byron Weintz, chief engr., Consolidated Rock Products Co., Los Angeles; N. H. Templin, Los Angeles County asst. chief deputy, road commissioner; L. C. Gilbert, Senior Asst. Tech. Secy., ASTM.

INDUSTRIAL WATER—Standing, l. to r.: G. R. Little, chief engineering inspector, Los Angeles Dept. of Water and Power; H. Ferry; L. C. Larson, exec. officer, California Regional Water Pollution Central Board; L. D. Betz, gen. mgr., W. H. & L. D. Betz; J. Jenson, board chm., Metropolitan Water District of Southern California; and Guest Speaker C. K. Rice, analyst, Gulf Oil Corp. Seated: Past President C. H. Fellows, director, Engineering Laboratory and Research Dept., Detroit Edison Co.; E. P. Partridge, director, Hall Laboratories, Inc.; R. C. Adams, supt., Chemical Engineering Lab., U. S. Naval Engineering Experiment Station; R. L. Derby, principal sanitary engr., Los Angeles Department of Water and Power; O. M. Elliott, Sun Oil Co.; P. J. Rich, tech. dir., Harvey Machine Co.; and R. E. Hess, ASTM Assoc. Exec. Secy.

RAILROAD—Seated, l. to r.: Guest Speaker J. W. Corbett, v.p. (systems operations), Southern Pacific Co.; ASTM Senior Vice-President R. T. Kropf, v.p. and director of research, Belding Heminway Co., Inc.; L. E. Sievert, exec. rep. of the pres., Atchison, Topeka & Santa Fe; B. F. Biaggani, v.p., Southern Pacific Co.; W. M. Barr, Honorary Member and Past President ASTM, consultant; ASTM Director E. F. Lundeen, asst. supt., quality control, Inland Steel Co.; M. A. Pinney, engr. of tests, The Pennsylvania Railroad Co.; Harry Welch, Western Precipitation Corp.; (standing) ASTM Exec. Secy. R. J. Painter; W. F. Collins, asst. chief, engineering services, New York Central System; S. M. Houston, gen. supt., motive power, Southern Pacific Co.; L. H. Winkler, honorary member, metallurgical engr., Bethlehem Steel Co.; Ray McBrian, engr. of standards and research, Burnham Lab., The Denver & Rio Grande Western Railroad Co., and pres., AREA; and J. W. Caum, ASTM Senior Asst. Tech. Secy.



nology; ASTM Pres. R. A. Schatzel; Guest Speaker K. B. Woods, head of School of Civil Engineering, Purdue University; toastmaster Paul Baumann, asst. chief engr., Los Angeles County Flood Control Dist.; W. S. Housel, assoc. prof. of civil engineering, University of Michigan; H. E. Hedger, chief engr., Los Angeles County Flood Control District; J. B. Howe, chm., Publicity Committee, assoc. and field engr., Maurseth & Howe; R. R. Proctor, field engr., Los Angeles Department of Water & Power; Robert Horonjeff, Institute of Transportation & Traffic Engineering, University of Calif.; T. P. Dresser, Jr., Vice Chairman, General Committee on Arrangements, and chief engr., Abbot A. Hanks, Inc.; and L. C. Gilbert, ASTM Senior Asst. Tech. Secy.

PRESIDENT'S NATIONAL LUNCHEON—At the head table, seated left to right were: ASTM Associate Executive Secretary R. E. Hess; ASTM Director E. F. Lundeen, assistant superintendent, quality control, Inland Steel Co.; ASTM Director G. H. Harnden, consultant; ASTM Director A. A. Bates, vice-president of research and development, Portland Cement Assn.; R. W. Truesdail, president, Truesdail Laboratories, Inc.; ASTM Director P. V. Garin, engineer of research and mechanical standards, Southern Pacific Co.; T. P. Dresser, Jr., chief engineer, Abbot A. Hanks, Inc.; ASTM Director C. R. Stock, group leader, physical measurements group, American Cyanamid Co.; ASTM Director E. J. Albert, president and treasurer, Thwing-Albert Instrument Co.; ASTM Director R. R. Litehiser, engineer of tests, Ohio State Highway Testing Laboratory; C. M. Wakeman, testing engineer, Los Angeles Harbor Dept.; Honorary Member L. H. Winkler, metallurgical engineer, Bethlehem Steel Co.; P. E. McCoy, American Bitumuls and Asphalt Co.; W. L. Chadwick, vice-president, Southern California Edison Co.; ASTM Director F. L. Laque, vice-president and general manager, Development and Research Div., International Nickel Co.; Honorary Member W. M. Barr, research consultant; Byron Weintz, chief engineer, Consolidated Rock Products Co.; ASTM Director, R. C. Alden, chairman, Research Planning Board, Phillips Petroleum Co.; ASTM Director, J. C. Moore, technical director, Coatings Research Group, Inc.; ASTM Director H. C. Cross, metallurgist, and assistant technical coordination director, Battelle Memorial Inst.; M. B. Niesley, president, California Testing Labs.; E. O. Slater, president and manager, Smith-Emery Co.; H. P. Hoopes, Pabco Products; standing, left to right: R. R. Miller, vice-president and general manager, Northrop Aircraft,

In the paper on the properties of beryllium copper strip, Richards and Smith of Penn Precision Products, Inc., showed that cold work and higher beryllium content improve the tensile strength and hardness both before and after precipitation hardness of the strip. New age hardening treatments for best strength and hardness were proposed and again precautions were given on hardness testing.

FATIGUE

Papers relate especially to aircraft industry problems

The two sessions on fatigue were by and large arranged by and for the aircraft industry. This industry, perforce, is very much concerned with the fatigue properties of materials and the prevention of fatigue failures.

Apart from three papers that dealt with the fundamental aspects of fatigue, namely, papers by Sachs, Muvdi and Klier of Syracuse University Research Inst, and Vitovec and Lazan, University of Minnesota, and Dorn, University of California, the papers covered various procedures that are used in the testing of joints and assemblies and the materials entering into them. The presentations included a movie in color on the testing of airplane assemblies. The papers themselves proved of considerable interest to the air-frame industry, and it is expected that they will be issued in a special publication in order to make them generally available.

NONDESTRUCTIVE TESTING

Report on ASTM Committee, and two-session symposium draw large and enthusiastic audience

A six-paper session especially arranged to inform members and others in the West Coast Area concerning the standardization activities on nondestructive testing of ASTM Committee E-7 drew an audience in excess of 100. Discussion was so lively that the session, originally scheduled to last two and one-half hours, was finally completed after three and one-half hours.

The papers comprised reports by subcommittee officers on activities in the fields of radiography, magnetic-particle testing, and ultrasonics. Chairman J. H. Bly of Committee E-7 also gave an outline and history of overall committee work. All papers emphasized that time and personnel do not permit many needed standardization projects to be assigned at present, and the hope was expressed that many West Coast people would participate, even if only on a correspondence basis.

Uranium, aircraft forgings, metal-to-metal bonds among tests described

This symposium, comprising nine papers, all by recognized experts in the field of nondestructive testing, was heard by an audience of over 150. Credit for organizing this most interesting and instructive session belongs to W. C. Hitt of the Douglas Aircraft Co.

Papers were presented by Eugene Roffman, Frankford Arsenal; R. F. Holste, J. E. Jacobs, and A. Pace, General Electric Co.; Donald Erdman, Electro Circuits, Inc.; and John Truell, Brown University, in the morning session. Mr. Roffman described eddy current and reluctance methods for detecting cracks in small cylindrical specimens and Mr. Jacobs outlined electronic X-ray image systems. A description of advanced electronic testing in Europe as seen in his recent trip was given by Donald Erdman. Mr. Truell outlined some recent developments in the use of ultrasonic attenuation and velocity measurements in the study of properties of materials.

The first paper of the afternoon session covering nondestructive testing on the Southern Pacific Railroad was presented by A. S. Pedrick and brought forth a tremendous discussion period. G. S. Tenney of the Los Alamos Scientific Laboratory described nondestructive testing techniques for

Inc.; L. P. Spalding, chief research engineer, North American Aviation, Inc.; H. H. Fuller, president, Bethlehem Pacific Coast Steel Corp.; Past-President H. L. Maxwell, special assistant to management, Engineering Dept., E. I. du Pont de Nemours & Co., Inc.; R. E. Gay, director, standardization, cataloging and inspection, Office of the Assistant Secretary of Defense; R. M. Mock, president, Lear, Inc.; Honorary Member W. C. Hanna, vice-president in charge of technical development, California Portland Cement Co.; General J. T. McNarney, president, Convair; ASTM Vice-President K. B. Woods, head, School of Civil Engineering and director of Joint Highway Project, Purdue University; J. H. Kindelberger, chairman of the board, North American Aviation, Inc.; ASTM President Schatzel, vice-president and director of engineering, Rome Cable Corp.; Past-President N. L. Mochel, manager, metallurgical engineering, Lester Branch, Westinghouse Electric Corp.; Guest Speaker Lt. General C. S. Irvine, deputy chief of staff, (Materiel) U. S. Air Force; ASTM Vice-President R. T. Kropf, vice-president and director of research, Belding Heminway Co., Inc.; D. A. Kimball, president, Aerojet-General Corp.; E. O. Bergman, technical adviser, C. F. Braun & Co.; Past-President J. R. Townsend, director, material and standards engineering, Sandia Corp.; L. A. Hyland, vice-president and general manager, Hughes Aircraft Co.; Past-President T. S. Fuller, consultant; C. W. Planje, president, Gladding McBean & Co.; Past-President L. J. Markwardt, assistant director, U. S. Forest Products Laboratory; Past-President C. H. Fellows, director, Engineering Laboratory and Research Dept., Detroit Edison Co.; and ASTM Executive Secretary R. J. Painter.

uranium. A wealth of data on the savings to Douglas Aircraft brought about by ultrasonic testing of aircraft forgings was given by Alex Barath. One of the techniques most desired by the aircraft industry has been a nondestructive test for the evaluation of metal-to-metal bonds as used in aluminum sandwich constructions. J. S. Arnold of the Stanford Research Institute described a recently developed ultrasonic test intended for this purpose. As an added attraction, this apparatus was exhibited at the close of the session. Last, but by no means least, H. E. Van Valkenburg of Sperry Products pointed out the pitfalls one must avoid in calibrating ultrasonic reflectoscopes, touching on a very extensive program being developed for the Air Materials Command with a view toward ultrasonic inspection by automation.

STRUCTURAL SANDWICH CONSTRUCTION

Elevated temperature and bonding materials tests dominate two sessions

The two major phases of the testing of materials and the application of sandwich construction, were discussed in two sessions. The extensive interest in this field of materials was shown by capacity audiences at both sessions.

Several papers dealt with high-temperature testing. J. R. Battalora and D. E. Pulsifer, Kawneer Co., portrayed a means of evaluation of adhesives under high-temperature conditions as used in aircraft structural application.

E. W. Kuenzi, U. S. Forest Products Laboratory, discussed test methods for evaluating the performance of structural-sandwich constructions at temperatures in the range of 75 to 1200 F. Edgewise compressive and flatwise flexural strength test methods were described in detail.

Recent developments in sandwich construction, including heat-resistant materials, was the topic of a paper by R. C. Steele, Hexcel Products, Inc. Structural efficiency and reliability of normal temperature sandwich has improved substantially, and sandwich materials are being produced for use at temperatures up to 1000 F.

Another paper in this group by W. G. Plumtree and W. Cheorvas, North American Aviation, Inc., relating to high temperatures discussed the effect of dimensional factors and temperature on the shear strength of aluminum honeycomb. The results of beam tests on several types of aluminum honeycomb conducted at temperatures from room to 260 F were presented, and a formula for shear strength of the core.

M. L. Sheridan and H. R. Merriman, The Glenn L. Martin Co., presented conclusions derived from empirical studies of bonded details for sandwich construction. The two features stressed the most in bonded details are the elastic behavior of the elements within the detail and the maximum strength capabilities of the detail itself.

Two papers related to adhesive bonds. J. S. Arnold, Stanford Research Inst, described an ultrasonic technique for nondestructive evaluation of metal-to-metal adhesive bonds using the STUB-meter or Stanford Ultrasonic Bond-meter.

Metal-to-resin adhesion as determined by a stripping test presented another approach to the subject. W. J. Snodden, Minnesota Mining and Manufacturing Co., described peel or stripping tests used as a means of obtaining adhesion in cases where at least one adherent is flexible. The methods presented are considered preliminary in nature but offer promise of further refinement.

J. M. Stevens, Department of the Navy, described typical applications for honeycomb-core sandwich construction in the manufacture of rotor blades and other parts in helicopters. The current general acceptance by the design engineer of sandwich construction is attributed to the development of adhesives and manufacturing processes that will produce reliable uniformly high-strength and durable bonds between the core and facing materials.

General Committee on Arrangements. . .

To the General Committee on Arrangements for the Second Pacific Area National Meeting goes a heaping share of credit for the success of the Los Angeles Meeting. To the essential of thorough planning they brought a contagious enthusiasm and breadth of scope that made all the features and events for the week abundant in activity and variety.

The above photograph shows many of the Committee and subcommittees at the Monday morning breakfast at the start of the meeting.

Although the majority of the papers related to aircraft usage of sandwich construction, a highly informative paper on selection of materials for architectural sandwich panels was presented by R. E. Parkinson, Kawneer Co. He emphasized that architectural sandwich construction was a potentially greater field than aircraft, and described desirable properties and the testing of facing, core and adhesive materials.

SESSION ON CEMENT

Air entraining capacity and hydrophobicity in storage

The session on cement, containing five papers, covered a wide range of subject material in the field. Two of the papers dealt with deterioration by atmospheric conditions and storage.

W. J. McCoy and S. B. Helms, Lehigh Portland Cement Co., reviewed the effect of storage on the air-entraining properties of portland cement. The results of their investigations over a period of five years indicated that air-entraining cement does not lose any appreciable amount of its air-entraining capacity if the storage is under proper conditions which prevent exposure to moisture or carbon dioxide.

Hydrophobic Cement was discussed by U. W. Stoll, U. S. Naval Civil Engineering Research and Evaluation Laboratory, Port Hueneme, Calif. He described the use of small amounts of oleic acid, producing a cement which resists hardening in sacks as well as caking in silos and batch bins. Through tests it was shown that a considerable reduction in grinding effort can be realized by intergrinding oleic acid in small amounts; up to 20 per cent air was entrained in mortars and 12 per cent in concretes; very small amounts of interground oleic acid increased the cement's ability to resist the effects of atmospheric moisture during storage; and the cost of materials for this treatment was less than 10 cents per sack.

The determination of magnesium oxide in portland cement by flame photometry has been one of the newer developments in chemical analysis technique. L. R. Pritchard, Lone Star Cement Corp., described the factors involved in this photometric type of analysis of cement, which up to now has been based on the Beckman DU Spectrophotometer with flame photometer attachment. A proposed method of test which has been developed in Committee C-1 on Cement was also described.

The remaining two papers were entitled Alkali Aggregate Phase of Chemical Reactivity in Concrete—Part II by J. A. Hester and O. F. Smith, Bureau of Materials and Tests, Alabama State Highway Department, and Carbonation of Hydrated Portland Cement by George Verbeck, Portland Cement Assn.

ELECTRODEPOSITED METALLIC COATINGS

Spring Meeting symposium repeated with equal success

The two sessions devoted to the Symposium on Properties, Tests and Performance of Electrodeposited Metallic Coatings comprised a representation of the symposium sponsored by Committee B-8 at the Buffalo Meeting in February. These authors were all present to make presentation and they were very well received indeed. The discussions followed along the same lines as those in connection with the original presentations in Buffalo. Two additional papers were presented; one by A. L. Alexander, Naval Research Laboratory, which was, in effect, a report of subcommittee work on the evaluation of phosphate coatings over electrodeposited zinc. The other paper by L. O. Gilbert, Rock Island Arsenal, described a method utilizing radioactive isotope dilution method for determining sulfate concentration in precision chromium plating baths.

Work is practically complete on the original papers and it is expected that the special technical publication, containing the papers of the symposium will shortly be issued.

CONCRETE

Large audience hears brief history of ASTM Concrete Committee and four papers

One of the largest audiences of the meeting heard the papers in the concrete session. Raymond E. Davis, director emeritus, Engineering Materials Lab., University of California and symposium chairman, opened the session by relating briefly the history of ASTM Committee C-9 on Concrete and Concrete Aggregates. He cited Committee C-9, sponsor of the session, as typical of ASTM cooperation with other societies, citing C-9's close liaison over the years with the American Concrete Inst.

Bryant Mather, Waterways Experiment Station, Corps of Engineers, presented data on the rating of performance of various types of portland cement with different quantities of various types of replacement materials, which evoked lively discussion.

A paper by R. E. Davis and G. E. Troxell, University of California, and D. McCall and R. A. McCann, Basalt Rock Co., described tests of prestressed expanded shale concrete beams under short-time and sustained loads. Prepared discussion was presented by Milos Polivka and extemporaneous discussions by many others in the audience.

F. L. Smith of the U. S. Bureau of Reclamation described various abrasion tests made by the Bureau to evaluate the effect of aggregate quality on the resistance of concrete to abrasion.

J. W. Kelly, Milos Polivka, and C. H. Best, University of California, described "point count method" determining the cement content of hardened portland-cement concrete by analysis of a cut section with a traveling microscope. The test shows considerable promise of being more accurate than the present ASTM Method of Test for Cement Content of Hardened Portland Cement Concrete (C 85). Estimated time for conducting a test is about 4 hours as compared with 14 hr for a test using method C 85.

ROAD AND PAVING MATERIALS

New equipment for rapid measurement of asphalt viscosity in absolute units demonstrated

Five papers, representing a wide range of subject material, yielded interesting information and data on aggregate and bituminous materials used for paving purposes.

Of considerable interest and promise was a new piece of equipment for the rapid measurement of asphalt viscosity in absolute units which was described and demonstrated by R. L. Griffin, T. K. Miles, C. J. Penther, and W. C. Simpson, Shell Development Co. Known as the sliding plate microviscometer, the apparatus is considered sufficiently accurate and simple to permit the measurement of viscosity in fundamental units in the control laboratory and eventually into asphalt specifications.

The operation, control, and application of an infrared weathering machine, designed by the California Division of Highways, was described by J. B. Skog. In the machine, compacted specimens are revolved individually in trays while being carried around on a large turntable. Studies indicate that a correlation of accelerated weathering with field-service life provides sufficient information for writing adequate specifications.

Reproducibility of test results in oven heat tests was discussed by R. S. Winniford, California Research Corp. Repeatability was determined for weight loss and retention of penetration data from the ASTM Method of Test for Loss on Heating of Oil and Asphaltic Compounds (D 6) and the thin-film oven test. The author outlined oven design factors that contribute to the lack of reproducibility between laboratories.

A critical survey of results of ASTM tests on asphalt was made by Ernest Zube, California Division of Highways. A cooperative program of tests involving four series and sixteen producer and four consumer laboratories indicated that all of the various ASTM and AASHO tests on asphaltic materials involved in the studies were out of control by ASTM definition.

The only paper on aggregate was by B. A. Vallerga, H. B. Seed, C. L. Monismith and P. S. Cooper, University of California, who discussed the influence of particle shape, size, and surface roughness on the strength of granular materials. They concluded that the angle of friction of uniformly graded materials up to about 0.2 in. in diameter does not appear to be affected by particle size and that the effect of particle shape on strength appears to be independent of particle size. The strength characteristics of a granular material are considerably affected, however, by a change in surface roughness of the aggregate particles.

MASONRY

Eight papers on variety of tests on masonry materials

A series of brief papers highlighted many of the problems pertaining to testing and research of masonry and masonry products. Albyn Mackintosh, consulting engineer, presented test data from which he concluded that allowable stresses shown in the 1955 Uniform Building Code are too low. Tests showed also that multiple courses of concrete masonry filled with grout and reinforced for tension are effective as a beam. The compression steel in reinforced masonry gives results similar to that in reinforced concrete. The bond between the mortar and the units was shown to be adequate to develop the strength of beams in flexure and shear. The data indicated that compression tests on masonry units are not an adequate measure of the quality of masonry units, and further research is needed to develop a better test. Further investigation also is needed to determine the cause of separation of grout cores from masonry units at time of failure.

P. V. Johnson, Structural Clay Products Research Foundation, described a program to develop test methods for producing blast loading on clay masonry walls. His paper was primarily concerned with the evaluation of the test methods and the signi-

With President Schatzel (second from left) are, left to right: P. James Rich, Technical Program Chairman; C. M. Wakeman, Chairman of the General Committee; and Past-President C. H. Fellows.

ficant quality of the data obtainable from the experimental techniques used.

The importance of testing to the clay pipe industry covering both the raw materials and the finished products was described by A. L. Bennett, Pacific Clay Products Research Laboratories. G. D. James, Gladding, McBean & Co., Los Angeles, maintained that many times random sampling is not the proper way to sample pieces characteristic of the products in the ceramic industry. His paper is largely a mathematical study on quality control taking into account many factors that are known to cause variations which are not considered in the random sample technique.

The research program on reinforced brick masonry undertaken at the University of California, Los Angeles, on behalf of University of California Division of Architecture, was described in a paper by J. M. English and R. R. Schneider, University of Southern California. Among the problems being studied are development of nondestructive techniques for the evaluation of completed masonry structures; investigation of bond between mortar, grout, and brick; the evaluation of large-scale masonry units; and a theoretical study involving design techniques.

Various tests used for determining the engineering properties of ceramic wall and floor tile were described by J. V. Fitzgerald and E. L. Kastenbein, Tile Council of America, School of Ceramics, Rutgers University.

Capping compounds were discussed in a paper by N. W. Kelch, Associated Brick Manufacturers of Southern California, and F. E. Emme, Raymond G. Osborne Laboratories. Their data showed the results of comparative tests on clay brick and on structural clay tile using two types of gypsum and two types of sulfur filler compounds for capping the specimens. Two thicknesses of cappings were used for comparative purposes.

SOILS

Investigations and testing covered in three sessions

A wide range of subjects covering the many aspects of soils investigation and testing was presented at the three sessions devoted to this important field of research and testing. Soils testing machines, electrical resistivity surveys, soil-cement mixtures, consolidation of pipe bedding, deadman anchorage tests, and many other varied topics were discussed in twelve papers.

A description of the newest model of a Universal soil-testing machine by J. W. Maloney, Dames and Moore, illustrated a machine said to be capable of performing a majority of soil strength tests used in soil mechanics. Automatic mechanical application of stresses and strains reduces labor time and human error and provides consistent and reliable test data.

A paper by R. O. Maurseth and S. N. Mitchell, Maurseth and Howe, presents one of the latest treatises on experiences with electrical resistivity surveys on foundation and subsurface investigations. The findings of the authors concur essentially with previously published reports of other investigators. The method is considered a valuable tool for the foundation engineer.

The strength and elastic properties of compacted soil-cement mixtures were reviewed by E. J. Felt and M. S. Abrams, Portland Cement Assn. Data of this type have been scarce, and this paper supplies needed information. The authors reported that modulus of rupture, compressive strength, and modulus of elasticity of soil-cement mixtures vary greatly depending upon soil type, cement content, age, and type of curing.

A distinctly different subject was covered by J. E. Smith, U. S. Naval Civil Engineering Research and Evaluation Laboratory, in describing tests of full-size concrete deadman anchorages in sand. The report was limited to horizontal loads applied to deadmen at different depths.

Experiences with the consolidation of pipe bedding by vibration on the San Diego Aqueduct was described by W. G. Holtz, U. S. Bureau of Reclamation. Information on the laboratory studies performed as a basis for procedures and materials criteria was presented. The experience on this and other projects has demonstrated that consolidated backfill produced a bedding much superior to compacted backfill.

Prof. R. K. Bernhard, Rutgers University, has been associated with dynamic properties of soils for a number of years. In his latest contribution he discussed the progress made to date in the determination of density and moisture contents of soils by means of nuclear disintegration processes, comparing various radiation sources. He referred to these investigations as microseismic studies.

A second paper by Dr. Bernhard covering the description for making soil density and soil moisture determination by radiation methods proved of considerable interest to those assembled. The paper by W. S. Housel on A Generalized Theory of Soil Resistance provoked a considerable amount of discussion since much of the work on foundations is involved.

BUILDING DESIGN FOR SHOCK LOADING

Earthquake danger is small if buildings are properly designed

A matter of some concern in the West Coast Area is the recurrence of earthquakes. Having this in mind this symposium was arranged under the joint auspices of Committee D-7 on Wood and Committee E-6 on Methods of Testing Building Constructions.

As explained in the introduction to the symposium, the actual danger is really quite small provided that buildings are properly designed. It is in view of this fact that special interest in the proper design of buildings for this area and methods of testing the various designs are being considered. As a matter of fact, these tests are of considerable interest to other areas as well even though not faced with the earthquake hazard since other loadings can be equally severe.

The formal papers were contributed by various agencies in the California area and by the U. S. Forest Products Laboratory.

FULL-SCALE TESTS ON HOUSE STRUCTURES

Expensive, time consuming tests require considerable instrumentation

Of equal interest was the Symposium on Full-Scale Tests on House Structures also sponsored by Committee D-7 on Wood and Committee E-6 on Methods of Testing Building Constructions.

Defense agencies in particular are faced with the need for economic, adequate designs and it is important that these be tested under various types of loading. Full-size tests naturally are quite expensive and time consuming and there are many problems in load application in connection with any simulation of natural conditions and considerable instrumentation is involved in stress and deflection measurements. The papers for the most part were contributed by the defense agencies, also a paper from the U. S. Forest Products Laboratory was included. In addition to the papers on

the program, the experiences in Australia were also described.

Of special interest was a series of tests conducted in wind conditions of up to 100 mph at Mt. Washington in New Hampshire.

SYMPOSIUM ON LUBRICATING OILS

Physical, chemical, and spectrographic analysis in petroleum products

This symposium presented the results of research studies on physical, chemical, and spectrographic analysis for determination of elements in petroleum products. An attendance of over 100 and the discussion gave evidence of the extensive interest in the work being done to develop satisfactory answers to the problems in this field.

Two papers described use of direct-reading spectrographic methods for (1) evaluation of used railroad oils by V. C. Barth, Chicago and Northwestern Railway and (2) control of the manufacture of lubricating oil additives, by R. E. Ramsay, California Research Corp., and W. A. Rappold, Oronite Chemical Co. In the latter, the speed of the instrument and method gave greater control at all stages of manufacture and resulted in the more effective use of plant equipment and laboratory manpower.

Likewise, in his paper dealing with the application of the X-ray spectrograph to refinery control of additive metals in lubricating oils, E. N. Davis, Sinclair Research Labs., showed that it is a quality-control tool for refining oil production. Significant savings were found in laboratory manpower and the time required to complete an analysis. Precision was reported to be at least equal to wet chemical methods.

W. D. Perkins, J. R. Miller, and J. H. Moser, Shell Oil Co., described the factors involved in the setting up of a direct-excitation spectrographic method for the analysis of used lubricating oils.

There was also available a compilation of a method of sampling and some suggested spectrochemical methods for near metals in used diesel lubricating oils. These methods were developed after a comprehensive study over the past five years of 15 spectrographic methods by 23 laboratories.

The symposium was concluded with three papers, the first of which by W. E. Lasky, Gulf, Mobile & Ohio Railroad, reviewed a number of unsolved problems in the analysis of diesel lubricating oils. The other two described the use of chromatography of diesel oils and the filtration of diesel engine lubricating oils. E. R. Thomas, Southern Pacific Railroad, dealt with chromatography, a spot test method of chemical analysis which utilizes the differential countercurrent distribution of the components of a mixture between a fluid phase and an interfacial phase. In this test there exists a certain absorption sequence according to which substances are able to replace one another.

In the filterability study by S. L. Earle, U. S. Naval Experiment Station, a limited amount of data obtained during tests of a submarine engine and a high-speed diesel engine showed that full flow filters provided good protection; high wear rates of some engine parts were reduced to satisfactory values.

SYMPOSIUM ON STEAM TURBINE OILS

High temperatures demand fire-resistant fluids

The possibility of fires from oil leaks in turbine systems has increased greatly as a result of the use of higher temperatures in turbine operation. This fact has stimulated investigation of fire-resistant fluids for steam-turbine application. Studies of various chemical-base fluids both in the laboratory and by field trial were described in the paper, Fire-Resistant Turbine Fluids, by G. H. S. Snyder, L. W. Manley, and N. V. Messina, Socony Mobil Oil Co. Since all organic compounds can be made to burn under some conditions but vary in their tendency to support combustion, the term "fire-resistant" was used to denote fluids of decreased flammability.

The authors emphasized the need for development of suitable test methods for evaluating these turbine fluids. The use of such fluids also involves problems of new design and operational considerations. The work being done by ASTM committees will contribute to the resolution of these matters.

In presenting his paper, Practices for Determining the Expected Life of Used Turbine Oils, R. G. Mastin, Cities Service Oil Co., stated that "modern turbine oils will last the life of the turbine." He presented data obtained from a turbine-oil testing service covering the past ten years.

A new technique using radiotracer measurements and electron micrographs was described in Nonmolecular Films of Rust-Preventive Additive, by H. E.

Members of the Ladies' Hostess Committee from left to right: Mrs. B. P. Weintz; Mrs. R. A. Schatzel, Mrs. R. J. Painter; Mrs. W. C. Hanna; and Mrs. E. A. Ledyard, Chairman. Below, the ladies enjoying a Fashion Brunch at the Beverly Hills Hotel.

Ries, H. D. Cook, and C. M. Loane, Standard Oil Co. (Indiana).

The anti-wear requirements for navy turbine oils were described by H. F. King and J. R. Bolt of Department of the Navy, Washington, D. C.

Methods for the evaluation and performance of turbine oils were described in a paper by G. H. von Fuchs, Doble Engineering Co.

RAILROAD MATERIALS

Changeover to diesel power requires new research and equipment

This very excellent series of papers dealt with the many problems that have been encountered by the various railroad companies in the extensive use of diesel fuel oils in the operation of diesel locomotives. The change-over from steam operation to diesel power has required the development of much new equipment and the establishment of sources of fuel supply. A great amount of research has been required by both the engine builders and the railroads to resolve these matters. The attendance of 175 at both sessions was evidence of the live interest in this subject.

In a comprehensive report P. V. Garin of the Southern Pacific Co. described equipment for a new method of operation of diesel locomotives with dual fuel systems. As the result of an extensive research program to develop less critical fuels for use in its diesel locomotives, Southern Pacific adopted in 1954 the use of the so-called "economy" distillate fuels for general service. Consideration was then given to the use of even lower cost fuels. A logical solution was to provide two fuels, one of higher quality, more critical for good idling and low output characteristics, and the other of lower quality, less critical for use during periods of high engine output. This led to the development of the dual fuel system.

J. L. Broughten and C. C. Moore, Union Oil Co., on the subject of lubricating oil requirements as related to diesel fuels indicated that the use of the light residual fuels will present many problems, and a lot of effort will be needed to find solutions. The best combinations of operating conditions, maintenance practices, and lubricating oil quality must still be worked out. The field test programs being carried out by the railroads, engine builders, and petroleum suppliers will provide practical answers to these interesting new problems.

Research studies of a laboratory test for burning inexpensive residual No. 6 fuel were also described by D. R. Jones, K. L. Kipp, and J. E. Goodrich, California Research Corporation. Since fuel is the biggest single item of operating cost of diesel engines this is of prime interest to the railroad industry.

G. C. Bernhard, XZIT Chemical Co., spoke about studies being made on the use of additives for economy-type diesel fuels. Some of the benefits that railroads would like to attain from an ideal additive or combination of additives are (1) retard formation of or disperse insoluble residue, (2) prevent injector sticking, (3) increase cetane rating, (4) improve combustion, and (5) reduce corrosion. Although there is no single additive at present that is able to supply all these benefits, much research is being done on this subject.

At the conclusion of the symposium there were presented two papers, one by J. L. Ramsey, Wyandotte Chemical Co., the other by C. F. Jursch, Southern Pacific Co., describing practical approaches to the standardization and use of railroad cleaning materials and methods. These papers described the many materials and equipment needed and the complications involved in their use on the many types of metals and finishes, also for the removal of soil constituents from the roof to tracks of railroad equipment and also from the exterior and interior of locomotives.

Members of the General Committee with President Schatzel are l. to r.: Chairman C. M. Wakeman; Mr. Schatzel; Treasurer B. P. Weintz, and Honorary Vice Chairman and Past-President W. M. Barr.

VAPOR PHASE OXIDATION OF GASOLINE

Research studies on problem of induction system deposits

The gasoline-powered internal combustion engine is today by far the largest source of power in the world. The existing 63 million automobiles, trucks, buses, and tractors represent over 7 billion horsepower, more than 50 horsepower per person. The successful operation of the gasoline engine in these millions of individual power plants is predicated on the rapid evaporation of the gasoline with air in the induction system, aided by heat at the manifold. This evaporation process must be carried out without having an appreciable residue on the inside walls of the induction system.

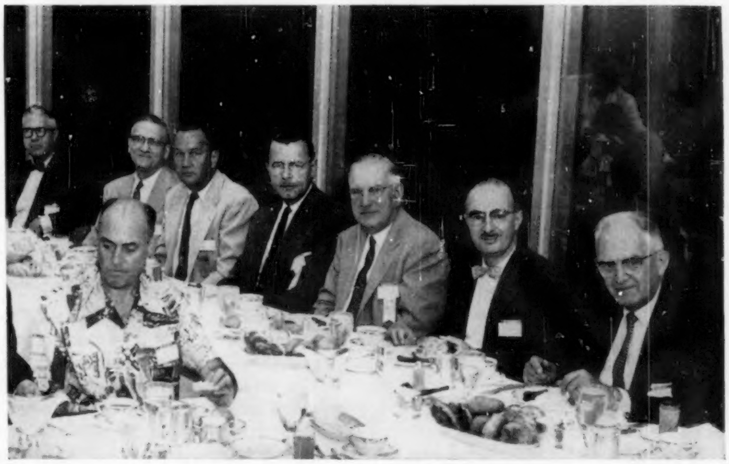
The four papers presented in this symposium described research studies on various phases of this problem of induction system deposits. There were two prepared discussions of each paper which contributed additional information and described other related studies. The attendance of 100 gave evidence of the wide interest in this subject.

The question of whether the induction system reactions are liquid or vapor were explored by A. C. Nixon, H. B. Minor, and T. P. Rudy, Shell Development Co. Their studies indicated that it is possible that some vapor-phase oxidation of gasoline occurs during passage through a manifold resulting in formation of deposits in the valve area and combustion chamber. However, the most pretensive reaction leading to deposit occurs in a liquid film in the manifold as a result of prior oxidation of the gasoline.

A. V. Cabal and J. Capowski, Socony Mobil Oil Co., Inc., described a test for

determining the effect of fuel composition upon intake valve deposit-forming characteristics of gasolines under both low and high temperature conditions. The procedure was a modification of the induction system deposit test reported in the 1954 Symposium on Motor Gasoline Stability. In this test a baffle tube provides an extension to the test manifold where temperatures were on the order of those attained on passenger car intake valve stems. The data showed that commercial gasoline antioxidants employed for storage stability did not affect baffle tube deposit-forming tendencies of the three fuels tested. Results indicated that the deposit-forming tendencies may be more related to the storage stability characteristics of the uninhibited fuel rather than that of the finished gasoline.

The many factors that influence the formation of deposits in the intake systems of carbureted engines were discussed at length by C. R. Bauer and H. J. Scheule, du Pont. It was pointed out that the new refining processes for producing high-octane gasoline have done much to reduce the incidence of manifold deposits. These studies also indicated the insignificant role of vapor-phase oxidation as a source of manifold deposits.



Councilors of the Northern and Southern California Districts met with officers of the Society at an outdoor breakfast. Seated, l. to r. Executive Secretary R. J. Painter; Past-Pres. H. L. Maxwell, E. I. du Pont de Nemours and Co., Inc.; Southern Calif. Dist. Chairman, M. B. Niesley, California Testing Labs., Inc.; ASTM Senior Vice-President R. T. Kropf, Belding Heminway Co., Inc.; ASTM President R. A. Schatzel, Rome Cable Corp.; Northern California District Chairman P. E. McCoy, American Bitumuls and Asphalt Co.; Past President C. H. Fellows, The Detroit Edison Co. In the foreground Carroll M. Wakeman, Los Angeles Harbor Dept., who was the hard-working chairman of the General Committee on Arrangements.

SYMPOSIUM ON PAINT

Use of silicones in protective coatings mushrooms

In order to acquaint those on the West Coast with some of the many investigative studies being carried on in Committee D-1 on Paint, Varnish, Lacquer, and Related Products, a series of papers was prepared by officers or active members of the D-1 subcommittees. This review covered in detail the many projects now under study: Drying Oils, Carbon Arc Light and Water Exposure Tests, Solvents and Thinners, Gloss Measurement—Past, Present, and Future, Methods for Preparation for Painting of Light Metal Alloy Surfaces, Progress in Measuring Color Difference, Latex and Emulsion Paints, and Varnish Testing.

Two sessions were devoted to a symposium comprising a number of papers in the paint field sponsored by the California Technical Program Committee. The extensive discussion at these sessions evidenced the wide interest in the project, providing the large number of paint companies in the Los Angeles area and the many large users of protective coatings an opportunity to review and discuss the newer types of paints and procedures for their testing and evaluation.

Of particular interest was H. L. Cahn's paper from General Electric on the use of silicones in protective coatings. Developed about ten years ago, silicones were first used as the vehicle for high-temperature-resistant paints. Since that limited beginning, silicone use in the paint field has mushroomed and now includes: (1) organic vehicle modifiers, (2) silicone copolymer vehicles, (3) electrical insulation coatings, (4) additives for correction of film defects, (5) additives for better processing and structural masonry water repellents. There was considerable discussion of the use of silicones by state highway departments, building contractors, aircraft manufacturers, and finishers for calculating machines.

The extensive use of vinyl metal finishes was also reviewed by C. I. Spessard, Union Carbide & Carbon Co., and particularly methods for their testing. Since their inception in 1930 production of vinyl coatings has now increased to 650 million lb in 1955, of which 27 million lb were used for coatings. Their use has run the gamut from corrosion-resistant systems to highly specialized decorative finishes.

Surface treatments of metal prior to painting which are now widely used and so important in the organic coatings industry, come in for attention by A. J. Tuckerman, Bradley Paint Co.

Allied to the Symposium on Railroad Materials was an excellent review by G. J. Grieve, Pacific Paint and Varnish Co., of protective coatings used in the railroad industry, which suffers a tremendous yearly loss from corrosion. The importance of proper preparation of the surface as well as full knowledge of the conditions to be met during the exposure life of the coating were stressed.

Other subjects covered were (1) evaluation of paints and protective coatings for municipal use, (2) methods for evaluation of protective coatings on metal surfaces in marine environments, and (3) control of phosphatizing systems.

The symposium was concluded by a paper on "Why Paint Specifications—Their Tests and Controls" in which it was stated that paint specifications are very useful to paint users. They should be so complete as to leave no area of conflict or argument. Paint specifications require test methods and procedures as essential components and these methods must be highly reproducible and tried.

PLASTICS SESSION

ASTM work in plastics reviewed

In addition to three interesting papers on various aspects of plastics, the Plastics Session featured a discussion of ASTM work, its origin, some of its developments and results in the field of plastics, by C. R. Stock, American Cyanamid Co., a Director of the Society, and F. W. Reinhart, National Bureau of Standards, Chairman of ASTM Committee D-20 on Plastics.

John Delmonte, Furane Plastics, Inc., in considering relationships between electrical and mechanical properties of

epoxy plastics, noted that for constant composition, changes in volume resistivity and flexural strengths will parallel one another for temperatures before and after the ASTM heat-distortion temperatures but that this temperature cannot be predicted from either set of data. A broad observation is that some relation exists between Shore-D hardness and volume resistivity. Resilient epoxy resins will, however, show significant electrical and mechanical changes on long-time aging at elevated temperatures.

Richard Anderson, North American Aviation, described unique equipment for nondestructive testing of bonded metal sandwich materials which are used so widely in many aircraft parts. Some of the advantages included ease of operation, constant scanning of the whole area, and ease of calibration.

INDUSTRIAL WATER AND WASTE WATER

Speakers relate topics to Los Angeles area's concern with water supply

Los Angeles is quite sensitive to the special situation that exists with respect to its water supply. The area has accordingly gone to extreme measures in establishing means of control and to insure the most efficient use of its water supply. In the two sessions held during the meeting, the industrial waste problems in Southern California were outlined and the water-pollution control described.

ASTM Director A. Allan Bates, vice-president of research and development Portland Cement Assn., conferring with Claude K. Rice, coordinator, Gulf Oil Corp. Mr. Bates spoke at the Cement Industry Luncheon and Mr. Rice at the Industrial Water Luncheon.

The sessions had been arranged by Committee D-19 on Industrial Water in order to bring its work to the attention of those on the West Coast who might be interested in participating. The function of Committee D-19 was ably described by its Vice-Chairman, R. C. Adams, U. S. Naval Engineering Experiment Station. In addition, the speaker at the Industrial Water Industry Luncheon, Claude K. Rice, also an officer of Committee D-19, discussed the cooperative relations between the various organizations interested in water testing and the need for such continued cooperation. Other papers at the session presented methods of water treatment such as the purification of salt water and new materials for clarification.

SYMPOSIUM ON WOOD PROTECTION FROM MARINE ORGANISMS

Preservatives to combat ravages of shipworm and gribble

The objectives in these papers represent one of the few occasions when the biologist and the chemist have attempted to get together with one purpose in mind. In this effort to protect wood structures exposed and submerged in natural waters, preservatives have been developed, tested, and used whose principal function is to combat the ravages of such marine organisms as the teredo (shipworm) and several kinds of limnoria, among others.

A paper by A. P. Richards, William F. Clapp Laboratories, reviewed marine exposure tests of wood treated with various preservatives ranging from full-scale service tests down to coupon specimens. The author stressed that while most test methods have value for specific purposes it is most important that extreme care be taken in the eventual use of the data obtained, a fact not new but doubly important in the testing of marine-exposed wood samples.

An interesting review of the kinds of borers and their distribution in U. S. was given in the paper by R. J. Menzies, Columbia University, and Ruth Turner, Harvard University. The two most common types of borers, the shipworm and the gribble or limnoria, were said to cause $50 million damage in U. S. annually. The most effective means of combating this destruction is a toxic or repellent covering of the vulnerable material.

Heavy metal compounds used as marine borer inhibitors were discussed by T. Roe, Jr., U. S. Naval Civil Engineering Research and Evaluation Laboratory. Various oxides of copper, silver, nickel, lead, mercury, and iron were used with varying degrees of effectiveness. However, wood impregnated with these compounds showed a relatively short service life in all cases.

A second paper from the same laboratory written by Harold Vind, Harry Hochman, James Muroka, and Joan Casey, described the relationships between limnoria species and service life of creosoted piling. The types studied compared particularly the limnoria quadripunctata and the limnoria tripunctata. The authors stated that it is important to identify all species of marine borers inhibiting a harbor.

An interesting account of the migration of the teredo, was given by C. H. Edmondson, Bishop Museum, whose observations were confined mostly to bays and harbors of several islands of the Hawaiian group.

SYMPOSIUM ON WOOD POLES

Papers point up need for more research

The need for research to reestablish the relative strength of poles of different species, the inconsistencies of present design stresses, and the economic effect on the use of wood poles that may result were discussed in a group of five papers.

L. J. Markwardt, U. S. Forest Products Laboratory, reviewed the need for research and the collection of authentic test data on full-size poles leading to the inauguration of the comprehensive ASTM Wood Pole Research Program.

A look ahead at wood pole production in relation to forest resource was given by E. E. Matson, Pacific-Northwest Forest and Range Experiment Station. Citing a current annual production of over 5 million wood poles of various species, he discussed the potential availability of pole timber on the basis of having sufficient resources under proper management.

The actual testing program of the ASTM Wood Pole Research Project was described by Lyman W. Wood, U. S. Forest Products Laboratory. The selection in the field, handling of test material, and the pole tests themselves were reviewed. The results of the tests indicate that very valuable data are being obtained in addition to the breaking strength. In particular, a quick and accurate field specific gravity test has been evolved.

George Q. Lumsden, Bell Telephone Laboratories, discussed the desirable

characteristics and properties of wood poles for use in communication lines—the advantages of a wood pole, possible areas of improvement, and wood preservatives.

The objective of L. G. Smith, Baltimore Gas and Electric Co., in his paper on engineering of specifications for wood poles, was to suggest points to consider in approaching the task of preparing a set of specifications that will give the user adequate strength and long life potential at minimum cost. This involves as precise a method as possible of rating the strength so there may be the least amount of excess wood. A second requirement is the imposition only of those prohibitions and limitations on defects that are essential to securing the desired strength and life.

GLUED LAMINATED AND OTHER WOOD CONSTRUCTIONS

New methods of using one of man's oldest construction materials

Although overshadowed by many of the more dramatic, newer materials, wood continues to be one of man's most important building products. This symposium covered a wide range of subjects within the wood construction field. R. E. Eby, Rilco Laminated Products, Inc., presented an interesting illustrated paper showing the development of glued laminated structures in which quality control in production is paramount.

Factors affecting strength and design principles in glued laminated construction, discussed by A. B. Freas, U. S. Forest Products Laboratory, were glued joint quality, lamination thicknesses, the effects of knots, cross grain, and end joints. Of interest also was the discussion concerning stresses induced by bending laminations to curved forms.

L. W. Wood, U. S. Forest Products Laboratory, discussed at considerable length studies made by the Forest Products Laboratory to evaluate the stress ranges for dimensional lumber. This is particularly important in light frame constructions.

Verne Ketchum, Timber Structures, Inc., took up developments in engineered wood design and construction. He observed that the more refinements there are in wood constructions the more expensive the item becomes and there is still a large field for timber construction which does not require the special work necessary for glued laminated construction.

Developments in softwood plywood design construction were described by David Countryman, Douglas Fir Plywood Assn.

MISCELLANEOUS PAPERS

Rubber, solvent degreasing, testing in guided missiles

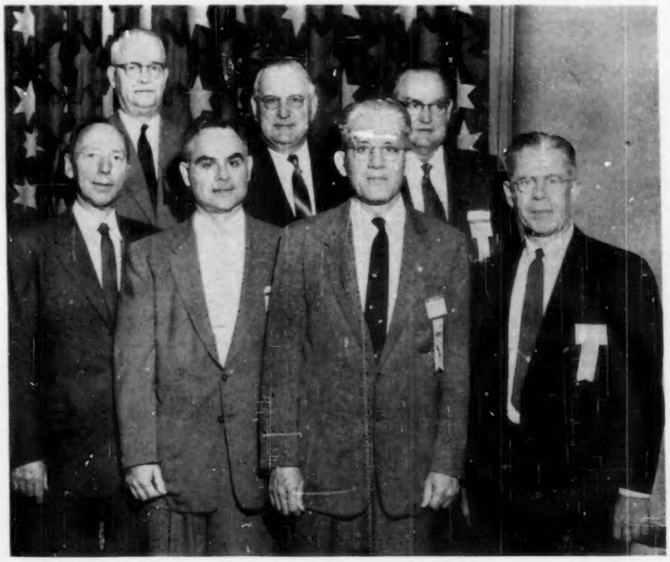
From its very nature this session included papers on diverse subjects; one on rubber, one on solvent degreasing, and one covering a very general subject on testing in the guided missile industry. However, even here the papers had a common theme, namely, calling attention to the further work that needs to be done. In fact the papers by Mrs. R. H. Sparling and C. E. Kircher specifically recommended that committee work be undertaken, and the paper by R. B. Stringfield urged that more attention be given to the use of specifications in purchasing rubber products and the advantages to be gained from their use.

December 1—Last Day for West Coast Meeting Papers Discussion

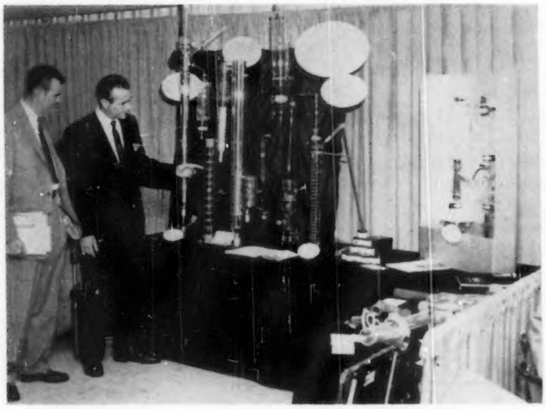
Written discussion of papers presented at the West Coast Meeting will be received by the Committee on Papers and Publications until December 1. In view of the fact that much of the published discussion is submitted after the meetings by letter, it will be helpful if all who can will send in their discussion to Headquarters well in advance of this date so that additional time is available to review and refer the discussion to authors for closure.

Diesel Oil Methods Available

The 88-page compilation "Suggested Methods for Spectrochemical Analysis of Used Diesel Lubricating Oils" is available from ASTM Headquarters, 1916 Race St., for $1 a copy. These methods were referred to in the Section J Committee Report on Spectrographic Analysis of Lubricating Oils as part of the West Coast meeting Symposium on Lubricating Oils.



At the Non-Ferrous Metals Session which included the repeat of the Gillett Lecture were (back row) l. to r.: E. O. Bergman, Vice-Chairman, General Committee on Arrangements; President Schatzel; presiding officer G. H. Harnden, ASTM Director and Chairman of Committee B-5 on Copper; (front row) presiding officer R. E. Paine, Vice-Chairman, Southern California District; Henry Burghoff metallurgist, Chase Brass & Copper Co., who presented D. K. Crampton's Gillett Lecture; ASTM Director H. C. Cross of Battelle Memorial Inst., joint sponsor with ASTM of the Gillett Memorial Lecture; and Past-President N. L. Mochel, first Gillett Lecturer.



Apparatus Exhibit Unusually Attractive

THE apparatus exhibit held in connection with the Second Pacific Area National Meeting was one of the most attractive ever arranged by the Society. The Wilshire Room in the Statler, having been designed especially for exhibits, provided the best of lighting which permitted the exhibitors to show their apparatus to advantage. Many of the exhibitors also had taken part in the show held at Atlantic City in June.

Among the items displayed were portable X-ray units; filter papers of all kinds; spectrophotometers; ultrasonic resonance test instruments, some automatic; polishing machines; petroleum testing apparatus; calibrating machines; and industrial X-ray film. New to ASTM exhibits was an automatic sampler in operation for automatic sampling of materials such as aggregates and coal. Also on display were microscopes of all kinds; stroboscopes; comparison bridges and other electrical testing devices; laboratory glassware; cameras; and a complete encyclopedia. Another item not previously exhibited was a concrete-core cutting machine. Tension testing equipment, carbon and sulfur analysis apparatus, bomb calorimeters, devices for gas chromatography, inspection gages and measuring instruments, and creep testing machines were also shown. Additional items were aluminum block heating baths, viscometers, and metallographic microscopes. One company had a booth at the show and also a trailer in a lot adjacent to the hotel in which some of its heavier and larger equipment was on display.

An important part of the exhibit itself again was the display by the ASTM Advisory Committee on Corrosion which had attracted so much attention at Atlantic City.

The photographs of the 10th Photographic Exhibit were also displayed at Los Angeles and attracted considerable attention.

PRESIDENT'S ADDRESS

Where Do We Go from Here?

By R. A. Schatzel

The interests of the American Society for Testing Materials are inseparably tied to the promotion of orderly competition in our free enterprise system. Anything concerning materials such as standards of quality, testing methods, research on properties—is a concern of ASTM.

The materials which go into the home we build, the clothes we wear, the machines that produce the power we use, and the wires and cables that make it available to our use, as well as the roads we drive on, the water used in our industrial plants, the cars we drive, and the marvelous planes that make meetings like this possible—and the fuels they use—are all in some way affected by the standards, or activities of ASTM. Note the broad range of subjects at this meeting: soils, industrial water, titanium, radiation effects on materials, and uses of radioactive isotopes. These gave an indication of the wide interests of the Society and their importance in our way of life. As for standards, our great engineer president, Herbert Hoover, once said "They have sharpened competition. They have cheapened the cost of production in millions of directions."

All this requires unselfish cooperation on the part of industry—both producer and consumer. We have their most competent materials experts and scientists as members, and over the more than fifty years of our existence their support has been unflagging. We acknowledge that with gratitude; and in view of the increased demands before us appeal for greater continued effort and support. Nowhere is this needed more than in the aircraft industry with the rapidly growing knowledge of materials and advancement in the technology of their evaluation, to perform safely under increasingly severe conditions.

The development of methods and specifications which are dynamic rather than static—subject to continuous examination, revision, and development—are the keystones to the orderly advancement of our economic as well as our technological progress.

The title of my talk—"Where Do We Go From Here?"—is perhaps a timely question. We would need first to ask where we are? Yes, we are in Los Angeles where we have held our first meeting of the Board of Directors west of the Mississippi River. (At our Board meeting, all but 4 of our 21 directors were present.) This is a tribute to the importance of and interest in the rapid growth and the place the West Coast has attained in our nation's industrial development. This present meeting, with its excellent attendance and broad coverage of subjects under discussion—as well as the graciousness of your welcome here—has more than justified and repaid those who have come great distances to attend.

We are also at the threshold of tremendous advances in technology and have come here, to a center of that activity. We have already mentioned the aircraft industry; allied to it is the guided missile industry. Represented here are also the fields of electronics and nucleonics as well as the great progress in automation and of fuels. It is a congenial atmosphere in which to contemplate the future.

We are also at a critical period in our technical and industrial development. Can this nation fulfill the demands required by the rate of progress expected of us and necessary to maintain our position? Before the turn of the century, a prominent English writer observed, "The fact is, that civilization requires slaves. Unless there are slaves to do the ugly, horrible, uninteresting work, culture and contemplation become impossible. Human slavery is wrong, insecure and demoralizing. On mechanical slavery, on the slavery of the machine, the future of the world depends."

Dr. Killian, president of Massachusetts Institute of Technology has pointed out, "As our technology becomes more complex it requires scientists, engineers, and managers of more advanced education and analytical skills."

The future these men envisioned is here. In sight are great developments where the slavery of machines will still further free men—and contribute to a fuller life and more leisure. Yet we are unprepared for it. We face a continuing labor shortage and educational crisis. The total work force for the next 20 years is here, now. The majority are in our schools—now.

It is generally recognized that the choice of vocation is made in the ninth or tenth grades—the choice of many has already been made—against science and engineering.

There is a steady percentage decrease in the number of students taking mathematics and sciences since 1900. Last year there were graduated 40 per cent fewer teachers licensed to teach mathematics and science than five years ago. We must reverse this trend.

This is of concern to our Society and to all industry; and a challenge for us to do something about it.

It is appropriate that I speak of this here, since our Northern and Southern California Districts as well as several other of our Districts are endeavoring to do something about it, through the sponsoring of Science Fairs, sponsoring of Student Membership Prizes in colleges, and helpful interest in engineering education.

I believe our Society and industry can both do more on the secondary school level to interest competent students in science and assist teachers in these subjects. Jules Verne interested youth for many years with imaginative tales of science accomplishment. Today the actual accomplishments of science are far more miraculous than Verne's inventions as evidenced by the real *Nautilus* compared to the fictitious. We have not sold youth on the romance of scientific accomplishments and have left to overburdened teachers the task of stimulating and guiding their imagination. Many years ago Oliver Goldsmith wrote these famous lines:

> "Ill fares the land, to
> hastening ills a prey,—
> Where wealth accumulates
> and men decay."

This may have a lesson for us if we neglect to develop the abilities of our youth. We need to give equal or more importance to the training of men than to the building of things.

Where do we go from here?

There is no question—we go forward to accept the challenge of obtaining better materials and performance which General Irvine,[1] will leave with us. The rate at which we accomplish this will depend on the continued coordination of technical knowledge through organizations such as ASTM and the character and quality of education of our youth.

[1] General Irvine's address on "Super Materials for Super Performance" will appear in a later BULLETIN.

ASTM Books in 1956—57

Publication Schedule Keeps Pace with Growth of the Society

The ASTM publications scheduled to appear within the next year are the results and crystallization of the Society's recent activities. The volume of publication continues to grow each year. The special technical publications which include symposiums and papers advance that phase of the Society's work concerned with the promotion of the knowledge of materials. The 1956 Supplements to the Book of Standards and the special compilations of related standards reflect the growth in work and the concentration on the Society's second objective—standardization of specifications and tests. Members will be posted on the appearance of these publications and will be furnished with convenient blanks to procure them. On almost all, special prices to members are in effect.

REGULAR PUBLICATIONS

1956 Supplements to 1955 Book of Standards

The plan of issuing the Book of Standards triennially marks 1956 and 1957 as Supplement years. The 1956 Supplements to the 1955 Book of Standards will be issued in seven parts in heavy paper covers. They will include the new and revised standards and tentatives adopted or accepted at the 59th Annual Meeting or by the Administrative Committee on Standards, and will total some 2400 pages. The seven parts are:

1—Ferrous Metals
2—Non-Ferrous Metals
3—Cement, Concrete, Ceramics, Thermal Insulating, Road Materials, Soils
4—Paint, Naval Stores, Wood, Cellulose, Wax Polishes, Sandwich and Building Constructions, Fire Tests
5—Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes
6—Plastics, Electrical Insulating, Rubber, Electronics
7—Textiles, Soap, Water, Paper, Adhesives, Shipping Containers, Atmospheric Analysis

Parts 2 and 7 are now being mailed. All parts are expected to be available before the end of the year.

Methods of Chemical Analysis of Metals

The 1955 Book of Standards does not include the ASTM methods pertaining to chemical analysis of metals. These methods will be published in a separate volume as the 1956 Book of ASTM Methods of Chemical Analysis of Metals which supersedes the previous book of chemical methods published in 1950. It is expected that the 1956 Book of Chemical Analysis will be available very shortly and should comprise 640 pages.

1956 Index to ASTM Standards

As the number of published ASTM standards becomes larger, this Index continues to increase in value. Providing the latest complete reference to the publications in which the various specifications and test methods appear, it is particularly useful during the years in which the supplements to the Book of Standards are issued. Publication of the new edition is scheduled for January.

Compilations of Standards

So many factors affect the release of these books that it is not possible to give any accurate estimate of their size or the date they will become available. The size is affected by committee recommendations which may be submitted through the Administrative Committee on Standards, and the date of issue is governed somewhat by editorial considerations and the relation of these special compilations to the appearance of the supplements to the Book of Standards, and also to a great extent by the publication load at the printers. The tabulation given below of special compilations therefore should be viewed as approximate:

1956 Proceedings

The 1956 *Proceedings* to be issued the beginning of next year will contain approximately 1300 pages of technical papers and discussion presented at the 1956 Annual Meeting. The discussions comprise a most significant and technically valuable feature of the *Proceedings*. All reports submitted by the Society's technical committees during the current year are also included. The Marburg and Gillett Lectures, issued as separate reprints, are also printed in the *Proceedings*.

The papers and discussions presented at the Annual Meeting as part of special symposiums will appear separately in special technical publications.

Year Book

The Year Book, which is now available, contains a list of the complete membership and official company-member representatives (name, title, address, company, etc.) personnel of all ASTM committees, as well as other useful information about the Society. It is furnished to members free of charge on request and may be purchased by committee members.

SPECIAL TECHNICAL PUBLICATIONS

The following symposiums featured as part of the 1956 Annual Meeting will be published separately with discussion:

Specific Gravity of Bituminous Coated Aggregates
Solder
Ion-Exchange and Chromatography in Analytical Chemistry
pH Measurement
Tension Testing of Nonmetallic Materials

Sponsoring Committee	Title	Approximate No. of Pages	Approximate Appearance Date
A-1	Steel Piping Materials	440	January
A-5	Corrosion of Iron and Steel	256	October
C-1	Cement	280	December-January
C-8	Refractories	350	January
D-2	Petroleum Products and Lubricants	1050	December
D-9	Electrical Insulating Materials	676	January
D-11	Rubber and Rubber-Like Materials	810	February-March
D-13	Textile Materials	810	November
D-15	Engine Antifreeze	64	Available
D-16	Benzene, Toluene, Xylene and Solvent Naphtha	64	Available
D-19	Industrial Water	460	November
D-20	Plastics	830	December

Steam Quality
In-Place Shear Testing of Foundation Soil by the Vane Method

In addition, the Symposium on Electrodeposited Coatings held at the Buffalo meeting and repeated at the Los Angeles meeting will be published as a Special Technical Publication, as referred to later.

Symposium on Specific Gravity of Bituminous Coated Aggregates (STP 191)

Sponsored by Committee D-4 on Road and Paving Materials

Specific gravity has an important role in the present-day design and measurement of compaction of bituminous pavements. It is customarily used in determining compaction of the bituminous mixtures. In the past, it has been the practice to measure individually the specific gravity of each component in order to determine the correct mixture proportions. This has not been an accurate or satisfactory procedure. The five papers presented in this symposium discuss various procedures whereby the specific gravity of the bituminous mixture may be measured quickly and accurately using small portions of the compacted mixture. The authors discuss the pitfalls involved in the choice of bulk and apparent and true specific gravity as a means of determining the proper ratio of bitumen to aggregate.

In the paper on "Measurement of Bituminous Concrete Core Densities and Density of Bituminous-Coated Aggregates by Means of a Volumeter," methods of measuring the volumes of bituminous-concrete cores and loose bituminous-coated coarse aggregates by air-pressure changes are described. A method is described in the paper on "Measurement of Maximum Theoretical Specific Gravity of a Bituminous Mixture by Solvent Immersion." Briefly, this technique utilizes an adaptation of a pycnometer method in which a bituminous mixture is placed in a large flask having a $1\frac{1}{2}$-in. ground-glass opening in which is fitted a top with a restricted neck for more precise volume measurements. In the paper on "Development and Application of the Effective Specific Gravity of Bituminous-Coated Aggregates," the authors obtained specific gravity by overfilling the mixture with asphalt and then calculating the effective specific gravity from an equation. A method for measuring the maximum specific gravity of voidless samples of bituminous paving mixtures is described in the paper on "Maximum Specific Gravity of Bituminous Mixtures by Vacuum Saturation Procedure." The procedure consists of removing entrapped air from a known weight of uncompacted mixture by evacuation and saturation under water. This procedure eliminates the need for conventional specific gravity tests on aggregates and bituminous material. A discussion of a new approach based upon a mechanically driven kneading compactor is presented in the paper on "Specific Gravity and Voids Relationships in Bituminous Pavement Mix Designs." This apparatus for compaction may possibly eliminate the need for determining the specific gravity of aggregate. In his paper on "The Role of Specific Gravity in the Design and Control of Bituminous Paving Mixtures," the author advises that while rule-of-thumb or empirical methods of compensating for absorption have been reasonably successful, there has been a long-standing need for convenient test methods that could be depended upon to provide a definite basis for design of bitumen content for any given aggregate and for computing the voids in compacted mixtures.

The test methods that are described in this symposium on specific gravity were devised in an effort to provide this definite information. They have, in general, the distinct advantage of a more direct approach to the basic problem than is provided by presently accepted methods of determining effective specific gravity of aggregates and the void content of compacted bituminous mixtures.

This symposium is scheduled for publication in November.

Symposium on Solder (STP 189)

Sponsored by Committee B-2 on Non-Ferrous Metals and Alloys

The importance of soldering in our everyday life can scarcely be overstressed. It is the one metallurgical operation that is probably known better and practiced, more or less aptly, by more people than any other. Aside from the amateur, the handyman, and the fix-it-yourself advocate, soldering is really of great industrial importance. Historically the use of low melting tin-lead solder goes back to Roman days, and beyond.

The fifteen soldering papers comprising the symposium can be classified into three major groups.

The first group, on the general subject of solders, includes two papers on soldering aluminum, one on soldering printed circuits, one on soldering semiconductors, and one on paste solder alloys.

The four papers of the second group deal with soldering fluxes. Each author approaches the subject from a slightly different viewpoint. However, there is unanimous agreement that the development of suitable test procedures is sorely needed for proper evaluation of fluxes, flux residues, and acceptability of the finished soldered joint.

Papers of the third group cover the general area of soldered-joint strength evaluation, including applicable methods and procedures. Three papers deal directly with joint evaluation; two with tin transformation and its effect on joint strength at low temperatures; one describes a proposed method for evaluating all phases of solderability; and the last discusses the application of quality-control procedures to improvement of joint quality.

The problems connected with soldering are manifold. Not only must the best solder composition be considered, but the proper flux, the best mechanisms for application, and the care of the joined parts afterward to give satisfactory life. This symposium was developed so that these items might be discussed by men who have secured worthwhile results in this field.

This symposium is scheduled for publication in December.

Symposium on Ion-Exchange and Chromatography in Analytical Chemistry (STP 195)

Sponsored by Committee E-3 on Chemical Analysis of Metals

The 1956 symposium is expected to be the first in an annual series of symposia sponsored by Committee E-3 on timely subjects of importance to ASTM members concerned with analysis of materials. They are being planned to acquaint ASTM members with new methods, techniques, etc., which are actually or potentially capable of use in standard methods of analysis.

This first symposium is intended to present a picture of the materials available, or under development, for ion-exchange and chromatography, the basic theory of their use, and examples of their application for separation and analysis of materials. Primary emphasis is on metals, but data of value to people concerned with other materials are included. Actually, three of the four papers present a coverage of ion-exchange and associated chromatographic techniques applicable to chemical analysis in general.

In the paper on "The Use of Ion-Exchange Resins in Analytical Chemis-

try," the authors tell us that the techniques developed are particularly useful for (1) concentrating a trace constituent, (2) removing an interfering element, (3) determining total concentrations, (4) purifying reagents, and (5) dissolving insoluble samples.

Several samples of separations which have been useful in radiochemistry and analytical chemistry are given in the paper on "The Use of Ion-Exchange Techniques in Analytical Chemistry and Radiochemistry." A number of ion-exchange methods for the separation and identification of both cationic and anionic fission elements have been developed. The total weight of many of these elements normally associated with materials which have undergone neutron bombardments enables a good test of the laws governing ideal solutions and the extension of the data to the concentration ranges normally encountered in ordinary analytical chemistry.

Separation of metals by ion-exchange may, in principle, be achieved by two techniques: cation exchange which operates on the positively charged metal ions, and anion exchange which operates on negatively charged complexes, and this is covered in the paper on "Anion-Exchange in Metals Separations." It appears that for many purposes the anion exchange technique is the more superior separations tool, principally since commercial organic anion exchange resins have striking selectivity for some complexes and since extensive complexing often accentuates differences between elements.

In the paper on "Ion Exchange in the Analysis of Metals" factors influencing the selection of a chemical reaction and resin type are discussed from the viewpoint of applied analysis with typical examples of some of the types of available procedures.

Symposium on pH Measurement (STP 190)

Sponsored by Committee E-1 on Methods of Testing

In the ten years that have elapsed since the first Symposium on pH Measurement was held at the ASTM 49th Annual Meeting in Buffalo, N. Y., significant progress in pH instrumentation and technology has been made. To keep pace with the expanding application of pH measurement, an operational definition of experimental pH values has been adopted. Agreement on standard pH methods is gradually being achieved as a single conventional standard scale comes slowly into general use throughout the world. Techniques have been devised for the accurate measurement of pH under specialized conditions of unusual difficulty, and much thought has been given to the precise role of pH in reactions of interest to the analytical and physical chemist. The increased laboratory and industrial importance of nonaqueous and partially aqueous solvents has stimulated the search for functions that will give a useful indication of the level of acidity and basicity in these media. It is the purpose of this second Symposium on pH Measurement to consider these new developments and to clarify the problems they have created.

Such questions as—just what is the pH value—what are its restrictions and limitations—what is recommended standard practice—what about measuring pH at high temperatures and pressures in nonaqueous solutions in blood—and what is involved in instrumention for pH measurements—are answered or greatly clarified in the seven papers comprising this symposium. Their titles are:

Meaning and Standardization of pH Measurements
Performance Studies of Reference Electrodes and Their Components at High Temperatures and Pressures
Modern Developments in pH Instrumentation
Problems in Measurement of the pH of Blood and Other Biological Fluids
Quantitative Applications of pH Measurements in Analytical Chemistry
Theoretical and Practical Problems in the Measurement of Acidity in Nonaqueous Media
Indicator Acidity Functions for Nonaqueous and Mixed Solvents

This symposium, scheduled for publication late this fall, will be an important permanent addition to the literature on pH measurement, bringing together as it does a well-rounded exposition of both the theoretical and practical aspects of the present state of knowledge of pH measurement.

Symposium on Tension Testing of Non-Metallic Materials (STP 194)

Sponsored by Committee E-1 on Methods of Testing

This symposium was arranged with the objective of providing (1) an accurate summary of present practices in fields where tension testing is most widely used, (2) a critical appraisal of their merits and deficiencies, (3) an opportunity to compare techniques and terminology among the various fields, and (4) a guide to future development and standardization.

One of the simplest physical tests that can be made on any material, is, at first glance, a measure of the tensile pull required to break it. Perhaps it is in part this simplicity, both of concept and of execution, which has made tensile properties a common denominator in material testing, especially in the field of metals.

Among the nonmetallic materials, however, there is such a diversity of structure and properties, that there has evolved a variety of methods for measurement of tensile properties. At least 60 such are listed in the ASTM Index of Standards. New materials have been developed for which older techniques are inadequate, new technical tools have been applied to the problem, new understanding of the structure of materials has brought a more meaningful interpretation of results, and each of these factors has contributed to the terminology and nomenclature of tension testing. By publication of this material it is hoped to accomplish the four objectives listed above.

The six papers comprising this symposium cover tension testing of adhesives, rubber, and plastics, present practices in tensile strength testing of paper, tensile load-deformation testing of textile structures, and tension test methods for wood, wood-base materials, and sandwich constructions.

Publication of this material is scheduled for January, 1957.

Symposium on Steam Quality (STP 192)

Sponsored by Joint Committee on Boiler Feedwater Studies

This symposium presents a review of current practices and introduces new techniques that will aid in obtaining the answer that is needed for the determination of steam purity in modern steam generators. The new techniques should give a more accurate picture of the solids that are vaporized as well as the solids that are carried over by mechanical means.

The 1941 symposium on steam quality marked the transition from determining the moisture in steam by measuring the temperature drop and reporting it in terms of percentage, to the determination of parts per million contamination and measuring it by conductivity instruments. Conductivity measurements with necessary corrections for dissolved gases had given most of the answers needed. With the introduction of higher pressures and higher steam temperature which resulted in the vaporization of dissolved solids in the boiler water, the need for a more sensitive and accurate measurement has been noted. Also the introduction of the once-through and the supercritical

pressure boilers make obsolete the present methods for determining steam quality.

Four papers comprise the symposium. In the paper on "Measurement and Purification of Steam to 0.01 ppm Total Dissolved Solids," the author describes a procedure based on occluding the solids in the steam by moisture produced by a pressure drop in steam passed through a suitable separator, and determination of the solids content by conductivity measurements or other suitable means.

It is pointed out in the paper on "Steam Purity Determination by Tracer Techniques" that measurement of mechanical carryover by the use of radioactive tracers is extremely sensitive and free of errors due to contamination; therefore this technique is suitable as a basis of comparison for other methods. However, because of cost, the use of this method for testing full-size boilers is impractical.

In "Comments on Corrections to Steam Conductivity Measurements," the authors discuss the nature and validity of corrections to steam conductivity measurements. They contend that higher corrections should be made for temperature effect on conductivity measurements than are currently being used, and that degassing should be verified (not assumed) in conductivity measurements.

The last paper, "Construction and Operation of Larson-Lane Steam Purity and Condensate Analyzers," covers the development of these instruments and problems encountered, including the effect of various hydrogen exchange resins on effluent conductivity.

The symposium is scheduled for publication late this fall.

Symposium on In-Place Shear Testing of Foundation Soil by the Vane Method (STP 193)

Sponsored by Committee D-18 on Soils for Engineering Purposes

The four papers of this symposium describe the various procedures in use and an exchange of experiments on the part of those who have been experimenting with this procedure. The so-called vane method was developed in the Scandinavian countries and some of the apparatus used in this country has been imported from these countries. Other experimenters have devised their own equipment. The symposium provides an opportunity for questions to be raised concerning the operation of the test equipment and to indicate in what respects further work will need to be conducted in order to develop procedures that will give comparable results.

The introductory paper gives an excellent outline of the various considerations involved, which are supplemented and amplified in the three other papers. One deals with a vane tester for determining the in-place shearing resistance of saturated clayey soils with the principal features of a controlled rate of testing and a simplified, accurate method of stress measurement. The paper on "Deep Vane Tests in Gulf of Mexico," describes the tool used to make a boring to a depth of 241 ft below the water surface; this tool combines the functions of drilling and vane testing. In the last paper on "Vane In-Place Soil Shear Measuring Device," the development of the device and the technique of using it are discussed. This device was built by the Construction Division of the Oregon State Highway Department and used since 1953 in investigating questionable embankment foundation areas along proposed projects.

This symposium is scheduled for publication in January.

1956 Marburg Lecture

The Marburg Lecture originated as a memorial to the first Secretary of the Society and was established to emphasize the importance of furthering knowledge of properties and tests of engineering materials. At the 1956 Annual Meeting, the 30th Edgar Marburg Lecture entitled "The Industrial Chemistry, Properties, and Applications of Silicones" was presented by C. E. Reed, general manager, Silicone Products Dept., General Electric Co.

Silicones are materials which extend the useful range of organic materials. Their expansion into new areas of utilization provides the basis for this lecture. Chemically speaking, silicones are constructed and synthesized much like their organic cousins. The point of departure lies in the strength of the silicone binding forces. This difference in bond strength accounts for their ability to withstand high temperature without decomposition, their chemical inertness to metals and most reagents, and a very low coefficient of viscosity with temperature.

Silicones may be cross-linked to form two-dimensional molecules. Such products have found a wide variety of use due to their excellent dielectric properties, good temperature stability, and chemical inertness. Further cross-linking will form three-dimensional networks of insoluble, infusible elastomers.

In his lecture, Mr. Reed discusses the basic chemical structure of silicones with particular reference to their similarities and differences compared with other industrially important polymeric substances, and the physical and chemical properties of silicones leading to their industrially important applications. Also included are the processes of manufacture, the important types of silicones and their applications, ending with a look into the future of silicones in selected industries such as electrical, aircraft, protective coating, and textile.

This lecture is scheduled for publication late this fall.

1956 Gillett Lecture

The fifth Gillett Memorial Lecture was presented by D. K. Crampton, director of research and development, Chase Brass & Copper Co., Inc., on the Structural Chemistry and Metallurgy of Copper. This lecture is jointly sponsored by ASTM and Battelle Memorial Inst. and commemorates Horace W. Gillett, the first director of Battelle and one of this country's leading metallurgists.

In his lecture, Dr. Crampton explores three aspects of microstructure of copper. The first portion covers some new work on recrystallization and grain growth of copper alloys, investigating time intervals much shorter than have been used heretofore. In the second portion, the lecturer deals with the structural chemistry of copper and copper alloys and more particularly the relation of grains and grain boundaries both in pure copper and some copper alloys. Also described are new investigations of the fundamentals of corrosion and corrosion resistance of copper and some of the factors affecting the incidence growth of corrosion pits.

This lecture is now available.

Symposium on Properties, Tests and Performance of Electrodeposited Metallic Coatings (STP)

Sponsored by Committee B-8 on Electrodeposited Metallic Coatings

This symposium presented at the 1956 Spring Meeting and Second Pacific Area National Meeting is sponsored by Committee B-8. These papers will be of great value to engineers and others concerned with materials, processes, and tests involved in the use of electrodeposited metallic coatings. The particular subjects presented are representative of the type of activity with which Committee B-8 is concerned, although they do not cover all subjects on which committee work has been carried out.

The "History of ASTM Committee B-8," covers the committee's activities from 1927. The second paper on "Corrosion Behavior and Protective Value of Copper-Nickel-Chromium and Nickel-Chromium Coatings on Steel," deals with exposure tests made over a period of years. The basic background and reason for the study was to determine the durability of plated coatings on auto bumpers and bumper guards and to establish the best thickness for various combinations of plate.

The matter of measurement of surface luster has been the concern of Subcommittee II, Section D, and the paper on "Evaluation of Methods Available for Measurement of Surface Luster of Electroplated Coatings" is a summary of progress made since 1948.

"Recommended Practices for Cleaning Prior to Electroplating" suggests that where possible cleaning be separated into a three-part process (1) precleaning—to remove the bulk of soil; (2) intermediate cleaning—to remove oily films; and (3) electrocleaning—to remove particles and other surface contaminants.

In "Comparison of the Corrosion Behavior and Protective Value of Electrodeposited Zinc and Cadmium Coatings on Steel," tests were conducted in three environments: salt spray (3 and 20 per cent), actual sea-water spray, and cyclic temperature and humidity test. These tests compare the corrosion protection of zinc with that of cadmium on steel surfaces.

A series of tests to determine the protective value of conversion coatings on zinc and cadmium are in progress and are described in the paper "Evaluation of Supplementary Coatings." This study compared methods of measurement of the thickness and density of the phosphate coating on both acid and alkali zinc electroplates. Tests made on coatings of lead plated on steel, tin-lead alloy, hot-dipped zinc, lead and terne plate at four outdoor exposure sites are described in "Atmospheric Exposure of Electroplated Lead Coatings on Steel."

The final paper evaluates the salt-spray test to determine whether it is used intelligently and whether results are interpreted properly. It is entitled "The Standard Salt Spray Test—Is It a Valid Acceptance Test?"

Two additional papers were presented at the Second Pacific Area National Meeting covering "Evaluation of Phosphate Coatings over Electrodeposited Zinc" and "Radioactive Isotope Dilution Method for Determining Sulfate Concentration in Precision Chromium Plating Baths." These may be included in the symposium volume. The papers with discussion comprising this symposium are scheduled for publication in November.

Symposium on Corona

Sponsored by Committee D-9 on Electrical Insulating Materials

There is a great need in the electrical industry for standard test methods for evaluating the corona resistance of materials. This is particularly true as operating voltages are raised and requirements for insulating materials become more stringent. This symposium provides a baseline for standardization of corona testing, and publication of the papers will provide permanent contributions to the literature on this subject. The papers, divided into corona resistance and corona measurements, are:

Corona Resistance

Preliminary Corona Resistance Test Results from IEC Activities

Effects of Corona on Thermosetting Plastic Laminates

Corona Measurement

Preliminary Investigation of Proposed Pulse Method for Measuring Ionization

Corona Detection and Measurement at Sixty Cycles

Test Methods for Measuring Energy in a Gas Discharge

This publication is scheduled to become available late this fall.

Symposium on Minimum Property Values of Insulating Materials (STP 188)

Sponsored by Committee D-9 on Electrical Insulating Materials

Minimum property values are test results which indicate the lowest expected result within a designated accuracy for a definite property of a specific material. Test methods to determine minimum property values are basic requirements for design purposes and anticipating service performance, but few methods allow prediction of suitability of materials before trial.

These papers are intended primarily to present the background of some few attempts to correlate general material test methods with expected service and design requirements. They are planned to be the forerunner of further work sponsored by Subcommittee XI of Committee D-9 on Electrical Insulating Materials—these covering the general field, while future discussions will delve deeper into specific properties or material types.

The seven papers comprising this symposium are as follows:

Introduction and Background

Low-Temperature Resistance Test Methods

Extremal Nature of Dielectric Breakdown Effect of Sample Size

Variability of Dielectric Breakdown in Sheet Insulation

The Establishment of Minimum Quality Levels

Statistical Treatment of Heat Aging Studies on Varnished Glass Cloth

Quality Level Cannot Be Determined by "Go"-"No Go" Gage

Publication of this symposium volume is scheduled for this fall.

Bibliographical Abstracts of Methods for Analysis of Synthetic Detergents (STP 150-A)

By J. C. Harris and R. Bernstein for Committee D-12 on Soaps

Since the issue of ASTM Special Technical Publication No. 150 in September, 1953, considerably greater interest in the analysis of synthetic detergents has become evident. The formation of 21 task groups of Joint AOCS-ASTM Subcommittee T-2 for the analysis of soaps and synthetic detergents has strengthened the need for this bibliography.

As far as possible, the original references have been abstracted with the peculiar needs of the analyst in mind. Where original references were unavailable, abstract journals were used, and these are given in such cases as secondary references.

No attempt has been made in every case to trace the origin of specific techniques or methods, but where these were available, this has been done. Some references have been included which it was felt might have bearing upon the development of applicable methods. The first reference, dated 1888, is much in advance of today's detergents, but it is significant as the basis for techniques which may currently be used.

The author index lists all authors alphabetically, indicating the senior author in all cases. The possible value of this is recognized by reference searchers. The subject index is cross-referenced for maximum usage and is sufficiently broad to provide individual method or compound as well as classification to cover type of analysis. Surface-active agents are subdivided into broad classes of anionic, cationics, and nonionics. These are further subdivided into individual classes or individual compounds.

It is expected that additions to the publication will be published as the volume of work in this field expands. While a conscientious effort has been made to include every reference found in the many papers abstracted for this

purpose, there will invariably be new ones brought to our attention. Therefore, the style of Metal Cleaning Bibliographical Abstracts will be followed to allow proper insertion of these references at a later date.

This 44-page book is now available and can be obtained from ASTM Headquarters. Price $1.50; to members, $1.15.

Relaxation Properties of Steels and Super-Strength Alloys at Elevated Temperatures (STP 187)

This report prepared by J. W. Freeman and H. R. Voorhees presents a compilation of all data gathered by the Subcommittee for Survey of Relaxation Data of the Data and Publications Panel including results previously reported under Project 16 of the Joint Committee on Effect of Temperature on the Properties of Metals.

Graphical data and graphical presentations summarize relaxation strengths for low-alloyed molybdenum-, chromium-, and vanadium-bearing steels with numerous other composition modifications, 12 per cent chromium type steels with many compositional variations, a number of superstrength alloys, and cast iron. Residual stresses for relaxation to 100, 500, 1000, and 10,000 hr are the main measure of relaxation strength. A lesser amount of data for the 10-hr relaxation strengths are given in some cases. The temperatures mainly range from 750 to 1100 F with data at 1200 to 1500 F for superstrength alloys. One set of data shows relaxation of high-strength carbon-steel wires at room temperature. The tabulated data also include chemical composition, heat treatment, mechanical properties at room temperatures, and limited creep data.

The relaxation strengths are shown graphically to indicate the ranges of values for the individual alloys. In this form, the range in strength for a given alloy was frequently rather wide. This was found to be mainly due to variations in initial stress, heat treatment, and major alloying elements. When sufficient data were available, graphical correlations were included to define the effect of these variables. It was very evident that direct comparison of relaxation strengths of different alloys could only be made on the basis of nearly similar initial stress. Curves of relaxation strength *versus* temperature on a reasonably comparative basis were developed insofar as possible for a single initial stress at each temperature. These initial stresses were arbitrarily based on those stresses for which most data were available. The comparative curves are also based on data for most usual conditions of heat treatment for each alloy. It is important to understand clearly that the level of relaxation strength indicated by the comparative curves would be different for any other initial stress in a majority of the materials tested and are therefore in no sense average strength.

This 97 page publication is now available. Price: $4; to members, $3.

Reference Photographs for Magnetic Particle Testing

Of particular interest to manufacturers and purchasers of iron and steel castings should be the development of a set of reference photographs of magnetic particle indications on ferrous castings. A task group consisting of representatives of Subcommittee III of ASA Sectional Committee B 31, the Manufacturers' Standardization Society of the Valve and Fittings Industry, the Steel Founders' Society, and ASTM, presented a set of these photographs to ASTM Committee E-7 on Nondestructive Testing at its June 22 meeting. It was endorsed with enthusiasm and the committee agreed to conduct an immediate letter ballot on approval for publication by ASTM.

The 42 photographs depict varying degrees of severity of linear discontinuities (cracks and hot tears), shrinkage, inclusions, internal chills, and unfused chaplets, porosity and weld defects. They were collected by the Steel Founders' Society from its member companies. Also included in the set are examples of false indications and magnetic anomalies. The reference photographs are intended for use when specified in contracts, orders, material specifications or codes, and when the limiting class of severity is mutually agreed upon by the manufacturer and the purchaser. Publication date has tentatively been set for early winter.

Five Year Index

This Index supplements the Fifty Year Index which covers all of the Society's publications up to 1950. Covering a five-year period it contains an index of all technical papers and reports published in all of the Society's publications through 1955. The Fifty Year Index plus this Supplement will present a useful adjunct of all technical libraries and users of ASTM publications. This Supplement of around 128 pages is now available.

Supplement to the Bibliography on Electrical Contacts (STP 56 J)

Sponsored by Committee B-4 on Metallic Materials for Electrical Heating, Resistance, Contacts

This is the third supplement published to the 1952 edition indicating that the work in this field is continuing at a high level of activity. This 40-page publication will be available this fall.

SECOND PACIFIC AREA MEETING PUBLICATIONS

The Second Pacific Area National Meeting held in Los Angeles the week of September 17 was in number of sessions, the largest national meeting sponsored by the Society. Many special technical publications will result from the symposiums held at this meeting. Many of the other papers will be published in the ASTM BULLETIN over the next year and some will appear in the 1956 and 1957 *Proceedings*. Future issues of the BULLETIN will provide definite publication plans regarding these papers. Published with the papers will be any discussion presented at the meeting. Sessions of the meeting are:

Symposium on Railroad Materials
Symposium on Lubricating Oils
Symposium on Steam Turbine Oils
Symposium on Vapor Phase Oxidation of Gasoline
Symposium on Titanium
Symposium on Properties, Test and Performance of Electrodeposited Metallic Coatings
Symposium on Structural Sandwich Constructions
Symposium on Industrial Water
Symposium on Full-Scale Tests on House Structures
Symposium on Nondestructive Testing
Symposium on Radioactive Isotopes
Symposium on Radiation Effects of Materials
Symposium on Paint
Symposium on Wood Poles
Symposium on Wood for Marine Use and Its Protection from Marine Organisms
Symposium on Building Design for Seismic and Shock Loading
Symposium on Developments in Glued-Laminated and Other Wood Constructions
Session on Non-Ferrous Metals
Session on Ferrous Metals
Session on Fatigue
Session on Cement
Session on Concrete
Session on Masonry
Session on Plastics
Session on Road and Paving Materials
Session on Soils

Session on ASTM Activity in Nondestructive Testing
Session on ASTM Activity in Paint

For more detailed information regarding these symposiums and sessions, see the article on page 5 of this BULLETIN which is a report on the West Coast meeting.

RECENT PUBLICATIONS

Several publications which have become available recently and which have been described in the past several issues of the ASTM BULLETIN are as follows:

Symposium on Impact Testing (STP 176) (May BULLETIN). Price $3.50; to members, $2.65.
Symposium on High-Purity Water Corrosion (STP 179) (May BULLETIN). Price: $1.75; to members $1.35.
Symposium on Speed of Testing (STP 185) (July BULLETIN). Price $2.50; to members, $1.85.
Methods for Reducing the Effect of Barometric Pressure in Measurement of Octane Number (STP 186) (July BULLETIN). Price: $1.50; to members, $1.15.
Selected ASTM Engineering Materials Standards (September BULLETIN)
Supplement to ASTM Standards in Building Codes (September BULLETIN). Price: $2.75; to members $2.

Quality Control Manual in Fifth Printing

THE fifth printing of 5000 copies of this very popular and useful manual brings the total printed to 31,000 copies since it was first issued in 1951. While the manual is essentially the same as it appeared in earlier printings, there is a brief but significant addition. The new item is the ASTM Tentative Recommended Practice for Choice of Sample Size to Estimate the Average of a Lot or Process (E 122) prepared by W. Edwards Deming and Mary N. Torrey, and it represents part of the work of Task Group 6 of Committee E-11 on Quality Control of Materials.

The manual has been officially endorsed by the American Society for Quality Control.

ASTM Manual on Quality Control of Materials, *STP 15-C*, 134 pages, is available from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa. Price: $2.25; to members $1.70.

ASTM STANDARDS AT WORK

The Delaware River Turnpike Bridge

Completion of the 6500-foot span this past summer, directly joined the pioneer Pennsylvania Turnpike and the heavily traveled New Jersey Turnpike across the Delaware River.

ASTM materials specifications figured prominently in the construction of this vital link in the nation's superhighway system. A cross-section of the ASTM steel, cement, and paint specifications used in the bridge shows:

Steel

- Structural (A 7 and A 243)
- Silicon (A 94)
- Rivets (A 141 and A 195)
- Concrete reinforcing bars (A 15)
- Zinc-coated wire strand (A 122)
- High-strength castings (A 148)
- Carbon steel forgings (A 235)

Cement

- Hydraulic cement
  - compressive strength (C 109)
  - air content (C 185)
  - time of setting (C 191)
- Portland cement
  - chemical analysis (C 114)
  - fineness (C 115)
  - slump (C 143)
  - autoclave expansion (C 151)

Paint

- Red lead (D 83)
- Red and brown oxide pigments (D 84)
- Raw linseed oil (D 234)
- Barium sulfate pigments (D 602)
- Magnesium silicate pigment (D 605)
- Testing drying oils (D 555)

Actions on Standards—September 5, 1956

Cast Iron

Specifications for Wrought Iron Pipe (A 72 – 55)

Revised and reverted to tentative status to bring the chemical requirements in line with all the other ASTM specifications for wrought iron by changing maximum permissible manganese content (Section 3) from 0.05 to 0.06 per cent.

Light Metals and Alloys

Tentative Specifications for Round Aluminum-Alloy Welded Tubes (B 313 – 56 T)

These new specifications were developed to cover a new product—aluminum-alloy tubes made from formed sheet and seam welded by continuous methods.

Chemical-Resistant Mortars

Tentative Recommended Practice for Installing Sulfur Mortar Joints (C 386 – 56 T)

The new tentative is intended to promote good practice in applying sulfur mortar in order to utilize its properties to the fullest and provide adequate safety precautions.

Concrete and Concrete Aggregate

Tentative Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete (C 387 – 56 T)

Representing something of a departure in ASTM specifications, this tentative was developed by Committee C-9 in response to advice that such specifications were needed for this product.

Manufactured Masonry Units

Specification for Building Brick (Solid Masonry Units Made from Clay or Shale) (C 62 – 50)

Revision to include a "Weathering Index." For many years it has been recognized that the criterion of less than 20 in. annual rainfall is neither adequate nor realistic in determining where certain grades of brick can be exposed without danger of disintegration. Moisture becomes a factor only when accompanied by cycles of freezing and thawing. Therefore it is only the precipitation that occurs during the winter months or during the period when freezing and thawing cycles occur that is of concern. The Weathering Index in which only *winter* rainfall, together with freezing cycle days are considered, represents a much more realistic criterion. (For complete information on the derivation of the Weathering Index, see page 39.)

Methods of Sampling and Testing Brick (C 67 – 50)

Tentative revision designed to include use of sulfur capping as an alternate capping material. This recommendation resulted from an extended period of research and study of the relative merits and acceptability of gypsum versus sulfur capping materials.

Specifications for Hollow Load-Bearing Concrete (C 90 – 52)

Specifications for Hollow Non-Load-Bearing Concrete Masonry Units (C 129 – 52)

Specifications for Solid Load-Bearing Concrete Masonry Units (C 145 – 52)

Experience in the use of these three specifications over the years had pointed to the desirability for inclusion of a more specific limit in cracks and small chips under the section, Visible Inspection.

Petroleum Products and Lubricants

Specifications for Gasoline (D 439 – 56 T)

Revised to reflect current octane number levels for regular and premium gasolines—a review made periodically by Committee D-2's Technical Committee A on Gasoline. In Table I, column headed Research Method Octane Number, min, the numbers are changed from "82 or 89" to "83 or 92."

Specification for Aviation Gasoline (D 910 – 56 T)

Revised to provide improved dyes to color the grades of aviation gasolines and a more convenient set of color standards to evaluate the color of the dyed gasolines.

Bituminous Waterproofing and Roofing Materials

Methods of Sampling and Testing Felted and Woven Fabrics Saturated with Bituminous Substances for Use In Waterproofing and Roofing (D 146 – 47)

Revised and reverted to tentative status in the light of experience since 1947 which has shown the need for refinement and changes in this method.

Textile Materials

Tentative Tolerances for Yarns Spun from Mixed Fibers (D 1454 – 56 T)

Tentative Tolerances for Spun Rayon and Acetate Yarns (D 1453 – 56 T)

Tolerances D 1454 apply to single or plied yarns of any of the following types spun from mixed fibers or fibers of different types: yarn spun on the (1) woolen (2) worsted, or (3) cotton systems.

Tolerances D 1453 relate to single or plied rayon and acetate yarns used for textile purposes. In both specifications the tolerances apply to nominal quality characteristics such as number, strength, twist, and extractable matter where the quality level has been agreed upon by the buyer and seller.

Industrial Water

Tentative Methods of Test for Sodium and Potassium Ions in Industrial Water and Water-Formed Deposits by Flame Photometry (D 1428 – 56 T)

These methods use both direct-measuring and internal-standard type flame photometers and include a procedure for each type. The direct-intensity method is employed for both types of instrument in analysis of water of high purity. Minor revisions have been made.

Wax Polishes and Related Material

Tentative Method of Test for 60-Deg Specular Gloss of Emulsion Floor Polish (D 1455 – 56 T)

Of the various methods for determining specular gloss, agreement has been reached on the use of this method which will be an integral part of the specifications which

Committee D-21 is developing. Specular gloss is one of several related appearance attributes that produce the sensation of glossiness and for this reason specular gloss measurements may not always correlate well with visual ranking of glossiness. It is defined as "ratio of reflected to incident light, times 1000, for specified apertures of illumination and reception when the axis of reception coincides with the mirror image of the axis of illumination."

Nondestructive Testing

Tentative Reference Photographs for Magnetic Particle Testing of Ferrous Castings (E 125 - 56 T)

This tentative was established as a result of a demand of the petroleum industry in cooperation with the Steel Founders' Society, American Petroleum Institute, and the Manufacturers' Standardization Society of the Valve and Fittings Industry. The photographs have been reproduced through the courtesy of the Steel Founders' Society from photographs obtained from its members companies. The photographs cover types and degrees of discontinuities in ferrous castings and are intended to assist in their classification. They are intended to be used for purposes of comparison with magnetic particle indications observed on actual castings.

Chemical Analysis of Metals

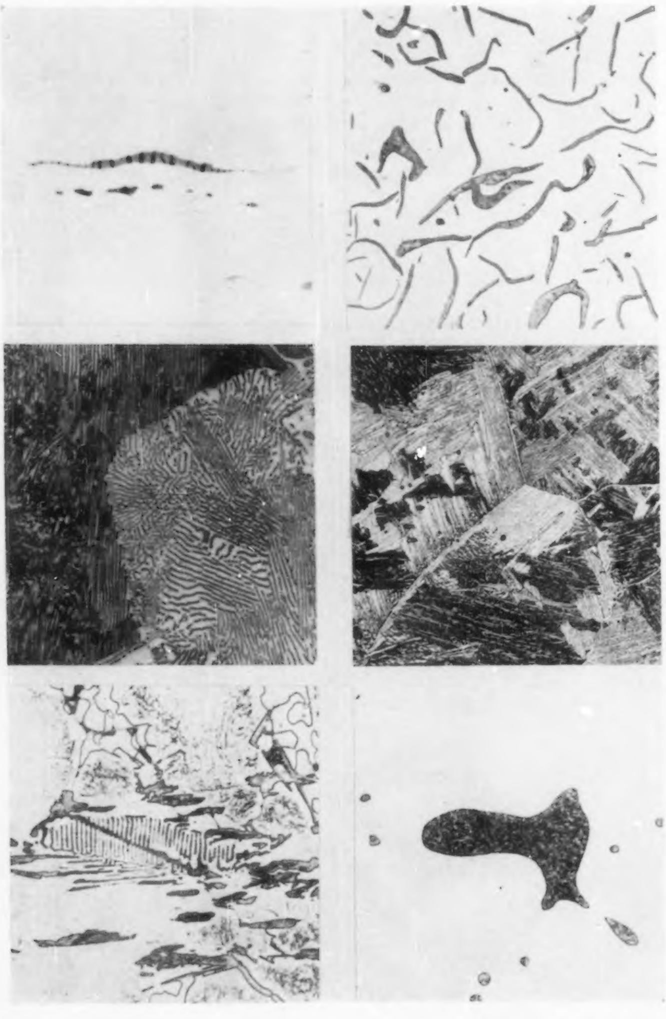
Tentative Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron (E 30 - 56 T)

Revised to include addition of a method for determination of sulfur by direct combustion-iodate titration. Difficulties encountered in the present method for determining sulfur published in standard Methods E 30 - 56, including use of theoretical factors, prompted preparation of this determination which considerably widens the utility of the procedure.

Joint Committee on Filler Metal

Tentative Specifications for Brazing Filler Metal (B 260 - 52 T)

Extensive use of this tentative, jointly sponsored by ASTM and the American Welding Society, has shown the need for certain revisions both technical and editorial, which have been worked out by a Special Task Group within Subcommittee VIII.



Diamond Abrasive Metallography (the Use of One Basic Polishing Procedure) *First Prize, Special Techniques—Tenth ASTM Photographic Exhibit. Edward C. Olden and V. McCann, Pitman-Dunn Laboratories, Frankford Arsenal, Phila., Pa.*

The submitted photomicrographs, left to right, manganese-silicate inclusion, flake type graphite, lamellar pearlite, titanium alloy, alum alloy, leaded brass, are representative photomicrographs of metallographic preparations using diamond abrasives. This technique represents a simplification of mechanical metallographic preparation. The various cloths, lubricants, wheel speeds associated with conventional mechanical preparations are usually dependent on the skill of the technician. The following basic procedure was applied for the above photomicrographs and duplication by comparatively inexperienced personnel should result in photomicrographs of the above quality.

Rough Polish

1—220 Silicon carbide speed wet paper
2—440 Silicon carbide speed wet paper

Intermediate Step

3—Cast Wax Wheel
(Paste type finishing carborundum)

Diamond Abrasive

4—5u-8 Roughing
☆☆☆☆Gamal Cloth
5—Ou-lu Finishing

Final Polish

Magnesium Oxide
☆☆☆☆Gamal Cloth

ACR Notes

Administrative Committee on Research

Student Research on ASTM Problems

By A. T. McPherson[1]

In the development of ASTM standards there arises from time to time need for accurate data on the constants of pure substances and the properties of industrial materials. Often a search of the handbooks and the original literature fails to disclose a determination of the desired quantity, and even when a value is found, it may not have been obtained at the requisite temperature, pressure, or frequency, or on a sample of the desired purity.

The need on the part of ASTM Committees for specific constants and properties has been publicized along with the need for other research through the medium of lists of unsolved problems. It has been hoped that the publication of such lists would lead to interest in, and work on, the problems. Little consideration, however, seems to have been given to the all-important matter of who will do the research, beyond the suggestion that some of the items might be suitable subjects for master's or doctor's theses in colleges and universities.

There may have been a time when suggested topics for major research endeavors such as graduate theses would have been welcomed in academic circles. Now, however, research projects in considerable number and variety are being urged on educational institutions by both Government and industry sponsors who are in a position to give liberal support to work that is in any way related to their interests. It is unlikely, then, that ASTM projects will be undertaken in a large way, unless, perchance, they coincide with projects sponsored by others. There is, however, one hitherto undeveloped source of data that could be exploited to a mutual advantage of both the universities and the ASTM.

Reference is made to the possibility of preparing materials and determining their constants and properties in connection with laboratory courses. It is highly desirable, to be sure, that courses in chemistry, physics, and engineering give a great deal of attention to the repetition of classical experiments that have been selected and designed for their teaching value. However, when courses include only carefully standardized textbook experiments, students tend to lose interest. The repetition of "canned" experiments year after year may even lead to the temptation for students to turn in the results on file in their fraternity house instead of their own observations. Interest could be stimulated and more effective teaching could be done if every course dealing with materials should culminate in the opportunity for the interested student to do a bit of original work.

A laboratory course in physical chemistry, for example, might be concluded with the determination of the thermodynamic constants of solutions used in plating. ASTM Committee B-8 on Electrodeposited Metallic Coatings has indicated the need for data on the activities, specific conductances, transport numbers, diffusion coefficients, and hydrolysis constants of solutions of a number of pure salts including the sulfates, chlorides, and cyanides of nickel, zinc, copper, and cadmium. By assigning one determination to a student, enough time and effort could be devoted to the work to obtain reliable values. If the project were undertaken at a single university, several years would be required to obtain all the data desired by the committe, but by interesting several different universities, the entire project could be completed in a year or two.

Similar activities could be suggested on many other subjects ranging from organic chemistry to engineering.

Work of this kind would necessarily require more care and the making of measurements with a higher degree of accuracy than in textbook experiments. From the standpoint of training this would afford the distinct advantage of giving the student the experience of doing work to meet the requirements of a real-life situation. In many instances projects calling for a number of determinations could be undertaken by a class in such a way as to give valuable experience in group research. Furthermore, the desired constants or properties could be arrived at by different methods, thus affording a valuable check on the accuracy of the determination.

A related and even simpler type of classroom activity would be the conduct of replicate tests according to new ASTM methods for the purpose of obtaining statistical information about the dispersion of results. This information would often be of much value to the responsible committees in evaluating the reliability and precision of the methods.

The success of student research such as is suggested here will depend to a large extent on the interest and inspiration of the teacher. The ideal situation would be a teacher, himself an ASTM member, who would be in a position to know just how the data are to be used. When this is not possible, an arrangement could be worked out whereby a member of the interested ASTM committee would make first-hand contact with the instructor and the class.

Participation in a project should be presented to the student as an opportunity rather than as a requirement. Experience with young people clearly indicates that where their interest in original work is aroused, they will exert a great deal of effort and obtain surprisingly good results.

Recognition could be given in many instances by appropriate acknowledgments in published reports where the data were used. Some of the data might even warrant presentation in a separate paper, especially where a number of students made related determinations. In all cases, however, it would be fitting and appropriate to recognize student contributions by election to student membership in ASTM.

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NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Second West Coast Meeting an Outstanding Success

ASSESSING the importance and significance of a tremendous technical meeting before all the "returns" are in may seem hazardous, but we are not talking about elections and there is no question that the heavy registration at the West Coast Meeting, excellent attendance at the technical sessions and Industry Luncheons, the many comments and commendations that have been received, indicate that this meeting was a big success.

And by success we mean that our fund of technical knowledge has been advanced greatly by the presentation of 200 technical papers. They represent the chief product of the meeting although the more than 100 meetings of technical committees, of course, resulted in much accomplishment in research and standards. These meetings, however, were not so well attended as is usually the case in the East, with the possible exception of the Cement and Concrete Committees in which the welcome presence of the technical committee personnel of the Portland Cement Assn. kept attendance about normal.

What made the meeting particularly noteworthy was the strong participation in the program of the representatives of the aircraft and allied industries in the West. Many papers were contributed by this great industry and much of the discussion and questions and answers came from the men in the inindustry who are concerned with the wide variety of materials that were covered; not only plastics and ferrous and nonferrous metals, but many others.

From the standpoint of attendance, the Industry Luncheons, the social program, and financially, the meeting was outstanding. Perhaps only after the last publication resulting from the meeting appears can we fully assess the value of this meeting, but there is no question in the minds of those present or of the many who contributed that it was truly successful.

We are very grateful to all those who had any part in making this meeting perhaps the most outstanding one held by the Society.

All Items on Standards Ballot Approved

THE canvass of the results of the 1956 letter ballot shows that the membership of the Society has approved all items listed on the ballot. These included the adoption of one new standard without prior publication as tentative, the adoption of 76 revisions of the existing standards, and adoption as standard of 124 tentatives. These actions will all be reflected in the Supplements to the 1955 Book of Standards that are now in preparation, with the exception that publication is being withheld of the Standard Method of Test for Sag of Thompson Wire (F 269), pending consideration of negative ballots that have been cast in Committee F-1 on Materials for Electron Tubes and Semiconductor Devices.

OFFERS OF PAPERS FOR 1957

THE Administrative Committee on Papers and Publications will meet in early February to consider the papers to be published by the Society in 1957 and to develop the program for the Annual Meeting to be held in Atlantic City, N. J., June 16–21.

All those who wish to offer papers for presentation at the meeting and publication by the Society should send these offers to Headquarters *not later than January 10, 1957.*

All offers should be accompanied by a summary which will make clear the intended scope of the paper and will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the Annual Meeting program.

Suitable blanks for use in transmitting this information will be sent promptly upon request to Headquarters.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
November 15	Joint Meeting—Detroit District and National Assn. of Purchasing Agents	Detroit, Mich.
November 15-16	Committee D-15 on Engine Antifreezes	Detroit, Mich. (Park-Shelton Hotel)
November 26-28	Committee C-13 on Concrete Pipe	Chicago, Ill. (Union League Club)
December 7	Joint Meeting—Southern California District and American Chemical Society.	Los Angeles, Calif.
December 10	Committee D-21 on Wax Polishes and Related Material	Washington, D. C. (Mayflower Hotel)
December 14	Washington, D. C. District	Raleigh, N. C.
1957		
January 21-23	Committee A-1 on Steel	Houston, Texas (Rice Hotel)
January 21-23	Committee D-19 on Industrial Water	Charleston, S. C. (Ft. Sumter Hotel)
February 4-8	**Committee Week**	**Philadelphia, Pa. (Benj. Franklin Hotel)**
February 10-16	Committee D-2 on Petroleum Products and Lubricants	New Orleans, La.
February 15	Southwest District	New Orleans, La.
March 19	Committee E-12 on Appearance	New York, N. Y.
April 25-26	Committee D-15 on Engine Antifreezes	Washington, D. C. (Shoreham Hotel)
May 20-24	Committe E-14 on Absorption Spectroscopy	New York, N. Y. (Commodore Hotel)
June 16-21	**Annual Meeting**	**Atlantic City, N. J. (Chalfonte-Haddon Hall)**

Advisory Committee on Corrosion Represents ASTM on CORROSION RESEARCH COUNCIL

THE Corrosion Research Council was founded to "stimulate and implement fundamental research in corrosion." With this statement of purpose the Council initiated its first research project in January, 1955. This project—Fundamental Reactions at the Surfaces of Metal Single Crystals in Selected Environments—is presently under way at the National Bureau of Standards.

The first progress report deals with the aqueous corrosion of the system copper-water-oxygen. In these experiments high-purity copper as single crystals are immersed in oxygen-free and oxygen-dissolved water.

The films of corrosion on the copper spheres are being studied in two ways: (1) increase in thickness with time by an electrometric technique or by measuring the change that occurs in the ellipticity of polarized light when it is reflected from the surface under study while the corrosion process is taking place, and (2) structure, relationship to substrata, compositions, and physical appearance by electron diffraction and electron microscopy.

These studies have not yet been able to discern the rate of corrosion on each crystallographic plane. However, vacuum apparatus has been constructed which will permit the removal of the initial oxide film existing on the copper surface by annealing the crystal in purified hydrogen at 500 C before immersing it in high-purity water containing varying amounts of purified oxygen and hydrogen.

Apparatus has been constructed which will grow single copper crystals by the Bridgeman method of slowly cooling a melt in vacuum.

The Engineering Foundation (whose activities were reviewed in the April, 1955, ASTM BULLETIN, p. 30) proposed and approved the formation of the Corrosion Research Council in February, 1954, with the following purposes:

1. To stimulate and implement fundamental research in corrosion.
2. To provide a sound basis for the control of corrosion by learning more about its fundamental causes and about the mechanisms by which it can be prevented.
3. To provide a body of scientific information on corrosion processes and control by the use of which industry can better solve its practical corrosion problems.
4. To encourage and assist institutions of learning in raising the quantity and quality of student training in the field of corrosion.
5. To encourage and assist in the publication and wide dissemination of the results of the research administered by the Council.

The establishment of the Corrosion Research Council points up the need for fundamental research in corrosion. Many organizations are interested in corrosion and have programs on various aspects of it. The National Association of Corrosion Engineers has since 1943 maintained six Technical Group Committees for the study of specific corrosion problems. The NACE also sponsors the Intersociety Corrosion Committee whose objective is to promote cooperation among technical societies working in the field of corrosion and to avoid excessive duplication of effort. The ASTM, through its Advisory Committee on Corrosion, not only sponsors a number of test sites for conducting exposure tests in which a number of ASTM technical committees are participating, but also spearheads the corrosion studies in the Society. It is through this Advisory Committee that the Society is represented on the new Corrosion Council.

Perkin Honored as Founder of an Industry

IN THE elegant halls and banquet rooms of the Waldorf-Astoria during the week of September 10, many scientists and technologists, and others interested in color, gathered to honor the founder of an industry. The Perkin Centennial Celebration, sponsored by the American Association of Textile Chemists and Colorists with participation of 28 other societies, featured an extensive technical program and exhibit with color in its many aspects as the Centennial theme.

Guest of honor, in spirit, was Sir William Henry Perkin who, 100 years ago in his home laboratory, synthesized mauve—the first coal-tar dye—while attempting to prepare quinine. The synthesis alone was quite an accomplishment but Perkin's really outstanding achievement was in his recognition of the commercial value of the new dyestuff, and his successful manufacture of the material with no precedents to guide him. Perkin, through his genius as both chemist and industrialist, set in motion the events which led to the present great synthetic organic chemicals industry.

ASTM Cosponsors Session

Scientists from Canada, France, Germany, Switzerland, United Kingdom, and the U.S.A., participated in a symposium on colorfastness of textiles, sponsored jointly by the AATCC and ASTM. This was the morning session on International Day, under the auspices of the American Standards Assn. and the International Organization for Standardization.

Keynoter for the Centennial at the Luncheon Session on International Day was Sir Robert Robinson, O.M., of the Society of Dyers and Colourists. In his address "Sir William Perkin—His Life and Work," he outlined the remarkable accomplishments of Perkin with some interesting sidelights on his personality.

Physics of Color

With the Optical Society of America and the Inter-Society Color Council, ASTM jointly sponsored a symposium on the physics of color at which G. W. Ingle, Vice-Chairman of ASTM Committee E-12 on Appearance, presented a paper on measurement of color differences.

Other sessions were devoted to the application of color to plastics, drugs, cosmetics, foods, leather, and textiles; the psychology and history of color; the manufacture of synthetic dyes; and color as related to fashion and to commerce generally.

The proceedings will be published in a special Centennial volume.

1955 Marburg Lecture Not in *Proceedings*

THE MANUSCRIPT of the 1955 Marburg lecture, the one delivered by W. H. Hamburger at the 1955 Annual Meeting on the subject, "Technology for Analysis, Design and Engineering of Textile Structures as Engineering Materials," was not completed in time for the lecture to be included in the 1955 *Proceedings*.

The regular printing of this lecture has been struck off, as announced in the September BULLETIN. A limited number of special printings have also been made available, for distribution on request, to those members who wish to have a copy for the sake of completeness of their 1955 *Proceedings*.

Technical Committee Notes

Cement and Concrete Committees Meet in Los Angeles During Second Pacific Area Meeting

C-1 on Cement

Progress was the keynote of the reports presented at the fall meeting of Committee C-1 on Cement, held in Los Angeles during the Second Pacific Area National Meeting.

Changes in specifications contemplated for action by the time of the 1957 Annual Meeting involve air content limits for blended cements and improvement in the specification for additions. A proposal, if accepted, will lead to the establishment of a minimum limit on relative humidity for cement laboratories, heretofore not required.

Ways and means for establishing closer coordination between Federal, AASHO, and ASTM groups responsible for specifications on cement, will be studied, in an effort to secure complete uniformity.

With respect to a number of test methods on cement and cement mortar, studies continue in the collection of observations in the field with laboratory tests on false set, sulfate resistance, and SO_3 content.

Plans for extensive cooperative test programs on strength determinations, and the application of mechanical mixing to the preparation of neat cement pastes, have been made. Desirable changes in fineness test methods are being discussed. Information on sampling devices is being assembled for inclusion in the sampling procedure specifications.

C-9 on Concrete and Concrete Aggregates

The use of raw or calcined natural pozzolans as admixtures for portland-cement concrete may now be controlled through a new specification, when confirmed by committee letter ballot and accepted by the Society. This action was taken at the fall meeting of Committee C-9 in Los Angeles. This specification will be a companion to the Tentative Specification for Fly Ash for Use as an Admixture for Portland-Cement Concrete (C 350). Some revisions of C 350 and the Methods of Test (C 311), were also accepted for letter ballot.

A complete revision of the Standard Method for Comparing Concrete on the Basis of Bond Developed with Reinforcing Steel (C 234) was approved subject to committee letter ballot.

Of interest as a research tool only, a proposed method for abrasion of concrete, involving a shot-blast type of equipment, was announced as being ready to present to the committee at the next meeting.

Measurement of the rate of hardening of concrete is covered in two separate test methods, both of which will now be circulated to the committee as information preliminary to action at the next meeting. The two methods involve the Proctor penetration resistance and the Bond pullout pin methods.

The study of sands with respect to their alkali reactivity is of current interest to the Subcommittee on Chemical Reactions.

The determination of the modulus of elasticity of plastic concrete has had no standard or uniform method and therefore no correlation of test results. A draft of a method for ultimate approval by the committee will now be prepared. This method will also include Poisson's ratio.

Several revisions of standards involving strength tests were accepted for immediate adoption: Making and Curing of Compression and Flexure Specimens (C 31 and C 192) and Methods of Testing for Flexure Strength (C 78 and C 293). The revisions pertain to the verification of testing machines and to changes in laboratory curing-temperature limits. Cooperative tests continue on the *L/D* factor for concrete testing specimens and a new testing outline was agreed upon.

Three projects in the field of lightweight aggregates include: (1) collection of test results on a staining test; (2) a method for the determination of unburned clay in lightweight aggregates; and (3) the effect of specimen shape and curing on the strength of insulating concrete.

Refractories

Committee C-8 Develops Classification for Silica Brick

Committee C-8, at its meeting in September at Manns Choice, Pa., set up a working group to expedite the handling of the U. S. participation in the International Standards Organization Technical Committee 33 within the committee.

ISO/TC33, during its first meeting in London in 1953, proposed the following scope for its activity:

> This Committee covers the raw materials and the products of the refractories industry which are not exclusively metal, and their properties. Refractory materials are defined as those having a minimum pyrometric cone equivalent equal to 1500 C (2735 F).

In a poll of six national associations and institutes and three U. S. Government organizations, it was the consensus that Committee C-8 should be the U. S. body to act as a participating representative on ISO/TC33. This ISO committee is currently working on definitions and methods of test for refractory materials.

During the meeting a classification for silica brick based upon current refractory practice was presented for committee ballot. This classification is based upon an extensive interlaboratory collaborative test program which chemically analyzed all commercially produced silica brick regardless of volume of production.

Reports from several industrial laboratories concerning the hydration resistance of a standard sample of refractory brick was received. In the light of the data gleaned from these tests a qualitative procedure will be prepared which will indicate the hydration resistance of dolomite, periclase, and basic refractory brick.

New projects undertaken are the hot-load test for small size specimens of refractory brick and a complete revision of the suggested classification of castable or hydraulic setting refractories.

The proposed specification for insulating fire brick for furnaces having negligible atmospheric problems will be sent to committee ballot.

Progress was reported upon the study of the effect of specimen shape on the

modulus of rupture, method of test for heat conductivity of hydraulic setting refractory materials, and classification of pouring pit refractories. Proposed specifications on mullite refractories and for sintered dolomite are currently being reviewed by industry for comment. A method of measuring permeability of carbon refractories is also being studied.

Cellulose and Cellulose Derivatives

International Committee for Cellulose Analyses Set Up

During its annual meeting in Atlantic City, N. J., September 19 and 20, Committee D-23, with representatives of several foreign countries, established an International Committee for Cellulose Analyses. The objective of this group is to compare and unify the standard methods of testing cellulose as used by various countries throughout the world.

A new group on chromatographic properties reviewed a large number of methods which are currently used in industry. These chromatographic methods will be studied and the most promising will be presented at the next meeting. Two interlaboratory collaborative test programs were established for absorption and color of cellulose and determination of ash constituents. Consideration is being given to the use of a carbanilation method for the determination of free hydroxyls in cellulose derivatives. Extension of a new viscosity method for cellulose to include desterified cellulose esters, by the use of desterifying agents, is being completed.

Two standard methods of hot leaching are being reviewed in order to develop a preferred method of assaying sodium carboxymethylcellulose.

Atmospheric Sampling and Analysis

Methods for Nitrogen Oxides Nearing Completion

Air pollution research by many organizations throughout the country is vigorous, as indicated by the large number of papers presented at the four-day Symposium on Air Pollution sponsored by the American Chemical Society at the 130th Meeting in Atlantic City, September 16–21. Several members of ASTM Committee D-22 on Atmospheric Sampling and Analysis presented papers or presided at sessions of the symposium. The committee, meeting on September 17 and 18, reported progress in the development of several much needed methods.

Methods for analysis of nitrogen oxides are being developed both by the analytical and instrumentation subcommittees and if progress continues at the present rate, these methods should be ready for recommendation as tentative in 1957. Other analytical methods are for sulfur dioxide as total sulfate, and determination of aldehydes either as total aldehyde or as formaldehyde.

Methods currently being considered by the instrumentation group include the nitrogen oxides methods previously mentioned, and a filter paper method for aerosols, a photometric method for aerosols, as well as methods for continuous recording of fluorides and oxidants.

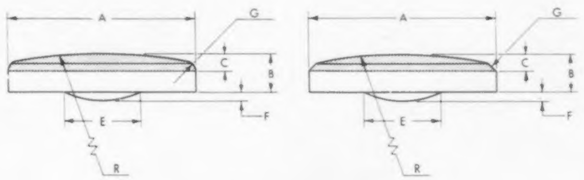
The sampling group is currently developing methods for sampling gases and vapors, sampling particulate matter, and stack sampling. The methods for particulate matter will be an adaptation of methods developed by the Air Pollution Control Assn.

Suggested Dimensional Standard for Projection Welding Electrical Contacts

Published as Information

To cope with the problems associated with an ever-increasing number of dimensional combinations of projection-welding electrical contacts, ASTM Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts, Subcommittee IV on Contacts has drafted a table of suggested preferred dimensions, which it hopes will eventually be adopted as a standard for the industry. Contacts of this type are constructed with a rounded button opposite the contact surface as shown. The button side is designed for welding the contact onto a spring or other support so that the contact may be used in a relay, switch, thermostat, or similar application. These suggested dimensions were included in a comprehensive article on electrical contacts which appeared in the September issue of *Electrical Manufacturing* under the title "Composite Electrical Contact Assemblies—II" by C. B. Gwyn, Jr.

Standardization of contact dimensions will encourage price reduction by reducing the number of sizes produced. Also, storage and handling problems would be simplified and delivery cycles would be improved. Standard dimensions will also help designers in selecting contact dimensions.



NOMINAL DIMENSIONS, IN.

Head Diameter	Total Head Thickness	Contact Material Thickness	Radius of Face if Domed	Projection		Edge of Contact Face	
				Diameter	Height	45 deg Chamfer	Radius
A	B	C	R	E	F	G Maximum	
0.125	0.050	0.022	Flat, 5/16, 1/2	0.062	0.008	1/64	1/64
0.187	0.050	0.022	Flat, 15/32, 3/4	0.078	0.010	1/64	1/64
0.187	0.059	0.031	Flat, 15/32, 3/4	0.078	0.010	1/32	1/32
0.250	0.050	0.022	Flat, 5/8, 1	0.094	0.010	1/32	1/32
0.250	0.059	0.031	Flat, 5/8, 1	0.094	0.010	1/32	1/32
0.250	0.093	0.042	Flat, 5/8, 1	0.094	0.010	1/32	1/32
0.312	0.059	0.031	Flat, 25/32, 1 1/4	0.156	0.010	1/32	1/32
0.312	0.094	0.062	Flat, 25/32	0.156	0.010	1/32	1/32
Tolerances for Contacts with Head Diam of 0.250 or Less							
±0.003	±0.003	±0.003	±1/64	±0.005	±0.002	...	...
Tolerances for Contacts with Diam over 0.250							
±0.005	±0.003	±0.003	±1/32	±0.008	±0.003	...	...

More Unsolved Problems . . .

Psychophysical Difficulties Seen in Appearance and Particle Size Measurements

Two committees dealing with seemingly unrelated problems are on common ground in at least one respect—judgment of the observer is an important factor in the results of a test. In both cases, measurements may be made visually or with instruments and the problems arise when visual measurements do not agree and there is poor correlation with results of instrument measurements.

The following problems have been contributed by Committees E-12 on Appearance and B-9 on Metal Powders and Metal Powder Products. They are presented in the form recommended by the Administrative Committee on Research, cosponsor of the unsolved-problems project with the technical committees of the Society.

High Gloss Measurement

Statement of Unsolved Problem contributed by ASTM Committee E-12 on Appearance

Problem:

Excepting one, the present standardized methods of gloss measurement are intended only to differentiate surfaces of medium and low gloss. The exception is the 20-deg procedure of ASTM Method D 523 (**1**) intended for high-gloss paints. In use, this procedure has been found to be unsuitable where there are differences in refractive indices between the paint films being compared.

For plastic films (both transparent and opaque), porcelain enamels, and high gloss paper coatings, there exist no standardized methods of gloss measurements, yet gloss is a commercially important attribute of all these, and other materials. Because all are glossy enough to reflect visible images, it is believed that generally similar measurement procedures can be developed for each, though details of specimen handling and data analysis may differ from one material to another. It would seem advantageous to work on all these materials at the same time both for the sake of economy and the possibility of correlating information between them.

Present state of knowledge:

Gloss is a psychophysical attribute of materials. By psychophysical, it is meant that the proper method of measurement is one giving results that correlate with estimates made visually by those accustomed to grading the materials in question.

Hunter showed in a paper given at the 1936 ASTM Annual Meeting (**2**,**3**) that there exist a number of appearance criteria by which the gloss of surfaces may be judged. Of the six criteria described, three are important in the rating of high gloss surfaces:

1. Distinctness-of-reflected images
2. Absence of haze or bloom
3. Surface uniformity or freedom from texture

Work by Wetlaufer and Scott (**4**) and recent work by Middleton and Mungall (**5**) and by Hunter (**6**,**7**) show that comparative measurements of haze, distinctness-of-reflected images and surface uniformity are possible, at least under some conditions. To date, however, there has been no broad attack on the problem of getting measurements by these new procedures to yield numbers correlating with visual ratings.

Questions that need to be answered:

1. How do results of new test procedures for distinctness-of-images, haze, and surface uniformity correlate with visual ratings by technologists familiar with enamel-type paints, lacquers, plastic films, porcelain enamels, and high gloss coated papers and boards?

2. Can commercially practical measurement procedures for the gloss of each of these materials be devised?

References

(**1**) Tentative Method of Test for Specular Gloss (D 523 – 53 T), 1955 Book of ASTM Standards, Part 4, p. 608.

(**2**) R. S. Hunter, "Methods of Determining Gloss," *Proceedings*, Am. Soc. Testing Mats., Vol. 36, Part II, p. 783 (1936); *Journal Research*, Nat. Bur. Standards, Vol. 18, p. 19, Jan., 1937, *RP 958*.

(**3**) R. S. Hunter, "Gloss Evaluation of Materials," ASTM BULLETIN No. 186; p. 48 (Dec. 1952).

(**4**) L. A. Wetlaufer and W. E. Scott, "The Measurement of Gloss," *Ind. and Eng. Chemistry*, Anal. Ed., Vol. 12, p. 647 (1940). See also *Bulletin No. 2115* of the American Instrument Co. (Silver Spring, Md.) "Aminco-Scott Glossmeter," May, 1943.

(**5**) W. E. K. Middleton and A. G. Mungall "An Instrument for the Measurement of Distinctness-of-Image Gloss," *Canadian Journal, Tech.* Vol. 3, p. 160 (1953).

(**6**) R. S. Hunter, "New Gloss Tests of Paper Products," *TAPPI*, Vol. 38, No. 1, Jan. 1955.

(**7**) R. S. Hunter, "Multipurpose Gloss Apparatus" (abstract), *Journal*, Optical Soc. Am., Vol. 45, p. 404, May, 1955.

Appearance of Metallic Surfaces

Statement of Unsolved Problem contributed by ASTM Committee E-12 on Appearance

Problem:

Technologists dealing with a variety of metallic surfaces have approached Committee E-12 or its individual members with requests for quantitative methods to measure the appearances of such surfaces. Some of the types of surfaces involved are:

1. Electroplated surfaces (particularly where "electrolytic polishing" is used)
2. Stainless steel
3. Rolled aluminum sheet
4. Cast-iron calender rolls
5. Rolled jewelry alloys
6. Silverware

Appearance desirability is extremely important in the foregoing materials which are used as automobile trim, household-appliance decoration, builder's hardware, costume jewelry, etc.

There are at present no standardized optical methods for measuring the attributes of this appearance desirability. There is thus an important need for psychophysical test procedures that will assign numbers to metallic surfaces correlating with attributes of their appearance desirability.

Present state of knowledge:

Although methods for rating the appearances of nonmetallic surfaces are well developed, these are not generally applicable to metallic surfaces because: (1) metallic reflectance is chiefly specular while nonmetallic reflectance is chiefly diffuse, and (2) freedom from diffuse and semi-diffuse reflectance are closely associated with what is called *metallic brightness*. This appearance attribute, which is very important for metallic surfaces, has no recognized counterpart for nonmetallic ones.

Colors of metallic surfaces may be measured by established procedures, provided specularly reflected light is collected for measurement. Goniophotometric methods may be used to evaluate geometric distributions of reflected light and these have already shown in a few cases that useful optical methods can be developed to measure attributes of metallic appearance. As was shown by Hunter in the ASTM BULLETIN (**3**), the relationships between geometric distributions of reflected light and surface appearances are frequently complicated. Appearance attributes such as haze, surface uniformity, distinctness-of-reflected images described in this article are believed to affect importantly the commercial values of metallic surfaces.

Questions that need to be answered:

1. How do the goniophotometric curves of metallic surfaces compare with visual ratings of their appearance acceptability?
2. Can useful reflectance procedures for rating "metallic brightness" be developed?
3. Will optical measures of surface uniformity be useful for appearance ratings of metallic surfaces?
4. Are "distinctness-of-mirror-image" methods needed to rate the appearance of metallic surfaces?
5. What limitations are imposed on optical methods for evaluation of metallic appearance by the general requirement of flat specimens for optical tests.

References

(**1**) L. Kenworthy and J. M. Waldram, "A Reflectivity Method for Measuring the Tarnishing of Highly-Polished Metals," *Journal*, Institute of Metals Vol. 55 p. 243 (1934).

(**2**) B. Egeberg and N. E. Promisel, "Studies in Evaluating the Brightness of Electrodeposits," *Journal*, Electrodepositers Tech. Soc. Vol. 13, paper No. 29 (1937).

(**3**) R. S. Hunter, "Gloss Evaluation of Materials," ASTM BULLETIN No. 186, p. 48 (December 1952).

Particle Size Measurement in the 1–10 Micron Range of Tungsten Metal Powders

Statement of Unsolved Problems contributed by Committee B-9 on Metal Powders and Metal Powder Products

Problem:

The need is urgent that users of tungsten metal powders find a suitable technique for determining particle size and size distribution on powders in the subsieve range. There is currently no method reported which is even promising for comparative results. It is felt that part of the difficulty lies in a tendency for tungsten metal particles to form agglomerates. The material "as received" is rather highly agglomerated, and the various techniques of preparation of samples for particle size determination act to deagglomerate the material to an indefinite degree. How great is the variation to be expected in the degree of agglomeration in the original material is not known, nor is it known to what extent the strength of the agglomerate bond may vary from batch to batch, or among several producers' materials.

Present state of knowledge:

A. The Microscopic Count Technique

This method has been used for years and is generally considered the standard method. A dispersion of tungsten powder in a suitable liquid medium is prepared as a microscope slide. This dispersion is projected at high magnification (3000–4000 $\times$), and an operator counts and records the particles by size range. This count is usually reported as per cent by count in range steps of 1 micron, and also as a calculated per cent by volume for the same steps. The operator must decide what to consider a particle and what an agglomerate, and while highly trained operators can repeat their counts rather precisely, there is unquestionably great disparity among different operators. Although the method has its faithful supporters, it must be considered as an artistic rather than a scientific technique, as it does not seem feasible to attempt specifications governing the interpretive function of the operator.

The precision of this technique has been investigated by the committee. Seven laboratories participated in evaluating samples of four types of tungsten powder circulated by a task group of the subcommittee. The powders had nominal average particle sizes of 1.5 micron, 2.5 micron, 6 micron, and 10 micron. On all types the tabulated results from the seven laboratories were so badly scattered that no rational approach to the problem could be suggested. For example, on the 10 micron powder, laboratory A reported a 3.3 per cent count for the $\frac{1}{2}$ micron size, while laboratory G reported a count of 49.9 per cent for this size on the sample.

B. The Turbidimetric Method

This method uses the change in light transmission through a glass cell filled with a dispersion of the powder in a suitable liquid. As the larger particles fall more rapidly, the transmission increases once all of the largest size particles have fallen below the level of the collimating slit, and continues to increase as smaller particles fall out. The intensity is measured by a photocell and galvanometer or, better, a recording instrument. From these data the percentage of particles in each size range is calculated by use of Stokes law.

Obviously the method is greatly influenced by the initial degree of agglomeration of the material, and by the amount of deagglomeration effected in preparing the sample.

Samples of the same four powders used in evaluating the microscopic technique were analyzed by this method by six laboratories. The lack of precision of the method is nearly as bad as for the microscopic method. Although different instruments, different suspension media, and different sample preparation methods were used, it was felt that results were so badly scattered that an attempt to standardize all these differences should await further evaluation of the method itself, especially in view of the difficulty of preparing suspensions with a controlled degree of deagglomeration.

Questions that need to be answered:

1. What is a tungsten particle?

One laboratory has produced evidence that the unit particles of tungsten powders in the 1 to 3 micron range are extremely small—on the order of 0.01 micron. The so-called particles of 1 to 3 micron are actually strongly bound agglomerates which can hardly be dissociated. In addition, there seems to be a variable tendency to form "super" agglomerates, which are loosely bound associations of the 1 to 3 micron agglomerates, and which can be broken up to some degree by the suitable application of mechanical energy.

2. How can the degree of deagglomeration be specified?

Regardless of whether the unit particle of tungsten powder is many times smaller than the nominal size, agglomeration of the nominal size particles is always present in the material as produced. It is of prime importance to be able to specify a standard method for deagglomerating, and the method must

be applicable to the particle size determination procedure. If the particle size analysis is to be used for manufacturing control—which is usual—the deagglomeration procedure should be able to duplicate whatever degree of deagglomeration occurs in the manufacturing process. The agglomerate bond is not of constant strength for a specified nominal particle size, but probably depends upon a number of factors in the reduction process, especially with hydrogen-reduced tungsten metal. In order to correlate the particle size analysis with manufacturing procedure, it seems likely that the deagglomerating technique will also have to be correlated with manufacturing procedure.

Introductory References

H. E. Schweyer and L. T. Work, "Methods for Determining Particle Size Distribution," ASTM Symposium on Particle Size, STP 51, 1941.

C. C. Gregg and B. Kopelman, "Particle Size Analysis of Metal Powders," Sylvania Electric Products Co.

M. N. States, "Specific Surface and Particle Size Distribution of Finely Divided Materials," *Proceedings*, Am. Soc. Testing Mats., Vol. 39, 1939.

L. T. Work, Methods of Particle Size Determination, *Proceedings*, Am. Soc. Testing Mats., Vol. 28, Part II, p. 771 (1928).

The Misuse of the Preece Test

By B. J. Barmack[1]

for Committee A-5 on Corrosion of Iron and Steel

THE EVALUATION of the Preece test discussed in the paper entitled "Some Observations on the Preece Test and Stripping Tests for Zinc-Coated Wires" by Ellinger, Pauli, and Orem, and presented at the 56th Annual Meeting of the Society in 1953[2] is an excellent presentation of test data to show shortcomings of that "popular" Preece test procedure.

The Preece test was first used by Pettenkofer in 1848, that is, 108 years ago, to test telegraph wires for the Bavarian Railway. About 1880 the test was also used in England by Sir William Henry Preece, for whom the test was named, for the same purpose. It was intended as a quick means to determine areas of minimum thickness of coating, but the results have frequently been distorted as indicating total weights of coating and the service life of the product.

As long as only one type of coating was being produced by the industry, comparisons between wires carrying coatings of different thicknesses, but of the same type, could readily be checked by the use of the Preece test. But when, for example, the electrogalvanized type was produced, the ASTM specification requirements for the number of Preece test dips had to be lowered for these electrogalvanized wires because of different rates of solution of zinc in copper sulfate.

Zinc-iron alloys dissolve in the standard solution at about half the rate for pure zinc; electrogalvanized coatings, consisting entirely of pure zinc, fail after only half as many dips as comparable weights of galvannealed (heat-treated) coatings. Hot-dip coatings, which consist of pure zinc and zinc-iron alloy, will withstand more dips than the electrogalvanized coatings.

This discrepancy led some manufacturers of hot-dip coatings to claim longer life for these coatings as compared with electrogalvanized coatings of the same thickness. This claim was disproved by the ASTM outdoor exposure of wires coated by different methods in the study made by Subcommittee XV on Wire Tests of Committee A-5 on Corrosion of Iron and Steel[3] and summarized by A. P. Jahn, then Chairman of the Subcommittee: "There appears to be no significant difference in the corrosion rates of the different types of galvanizing when all exposure sites are considered. However minor differences at specific sites are shown. The electrogalvanized specimens had a higher corrosion rate than did the hot-dip specimens at Pittsburgh, Pa., but had a lower corrosion rate at Sandy Hook, N. J., than all other types and were about average at other locations. The heat-treated specimens had the lowest corrosion rate at Pittsburgh."

It is true that the Preece test can be used to determine the uniformity and distribution of the zinc and whether there are thin spots in the coatings. The test was retained in the Specifications for Hardware (A 153)[4] because for irregularly shaped articles the calculation of surface area is very difficult and often impossible for an average inspector.

The development of nondestructive methods using magnetic gages now reached such a stage that not only the average thickness of zinc coating can be determined quickly, but even the uniformity and the distribution of zinc can readily be checked over the entire piece.

The subject of accuracy and reproducibility of measurements using magnetic gages is of special interest now to Subcommittee VII on Methods of Testing of Committee A-5.

Messrs. Ellinger, Pauli, and Orem are to be congratulated upon the thoroughness of study of the weight of coatings on various wires using, in addition to the standard method A 90,[5] three other chemical methods, one metallographic, and one magnetic-gage method.

This investigation by the National Bureau of Standards was the result of a controversy in Subcommittee XII of A-5 on the interpretation of end points in the Preece test as described by Groesbeck and Walkup in 1934.[6]

Present investigation by Ellinger, Pauli, and Orem merely confirmed the findings of Groesbeck and Walkup that sometimes there is a lack of consistency among results even from the same type of coating. The definition of the end point in the present ASTM Standard Method of Test for Uniformity of Coating by the Preece Test (A 239[7]), which had its foundation in the work of Groesbeck and Walkup, was changed in 1941 in such a manner that wire which previously passed say, four dips, now has to withstand only three dips.

Due to inconsistencies in the Preece test as described by the authors, this test has been recently removed from wire specifications of Subcommittee XII on Wire Specifications of A-5 as the ASTM Committee A-5 did to sheet and plate specifications way back in 1911.

In addition to magnetic type laboratory instruments there are now available small portable magnetic thickness gages which are proving their worth and it is hoped that the use of the Preece test will soon disappear from all ASTM specifications where it is still prescribed. The work of the authors of this investigation shows very conclusively that the Preece test may be of some use in a laboratory but is of no great value and often causes trouble when used in the average shop.

[1] Formerly Chairman of Preece Test Section, Subcommittee VII of Committee A-5.

[2] *Proceedings*, Am. Soc. Testing Mats., Vol. 53, p. 125 (1953).

[3] A. P. Jahn, "Atmospheric Corrosion of Steel Wires," *Proceedings*, Am. Soc. Testing Mats., Vol. 52, p. 987 (1952).

[4] "Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware," 1955 Book of ASTM Standards, Part 1, p. 1174.

[5] "Methods of Test for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles," 1955 Book of ASTM Standards, Part 1, p. 1141.

[6] *Proceedings*, Am. Soc. Testing Mats., Vol. 32, Part II, p. 453.

[7] "Method of Test for Uniformity of Coating by the Preece Test (Copper Sulfate Dip) on Zinc Coated (Galvanized) Iron or Steel Articles," 1955 Book of ASTM Standards, Part 1, p. 1189.

Derivation of a Weathering Index for Brick

STANDARD Specifications for Building Brick (Solid Masonry Units Made from Clay or Shale), ASTM Designation C 62–50,[1] classify brick according to their resistance to frost action which, in most products, may be taken as a fairly accurate measure of their resistance in masonry structures to the agents of weathering. This specification covers three grades: SW (severe weathering), MW (moderate weathering), and NW (no weathering).

The specification provides, in Section 2 (*e*): Waiver of Durability Requirements, that the requirements for water absorption and saturation coefficient, which together constitute a measure of resistance to frost action, may be waived "where no frost action occurs or, if frost action occurs, where the annual precipitation is less than 20 inches."

On June 17, 1956, ASTM Committee C-15 on Manufactured Masonry Units voted to modify the criterion for the waiver of the requirements for durability and also eliminated the use of grade NW brick where the unit is exposed to weathering.

Under the new criterion, durability requirements (saturation coefficient and water absorption) may be waived for areas where the weathering index is less than 100, provided the compressive strength of the units is at least 2500 psi; that is, provided the units meet the minimum strength requirement for grade MW.

Annual Precipitation Figure Inadequate

The committee recognized that the use of total annual precipitation as the criterion for severity of frost action is inadequate. Snow, included in precipitation, would not introduce water in vertical surfaces where most brick are used. There are areas of the country which have less than 20 in. of precipitation annually and which have more winter rainfall than areas with more than 20 in. of annual precipitation. Consider the comparisons in Table I.

Prior to the revision of the specification, one would presume not to use NW brick in LaCrosse, Wis., but in Pendleton, Ore., presumably NW brick would be used. Pendleton, however, has more winter rain than LaCrosse. The same condition is even more strikingly evident in a comparison of Denver and St. Cloud. Other examples could be cited.

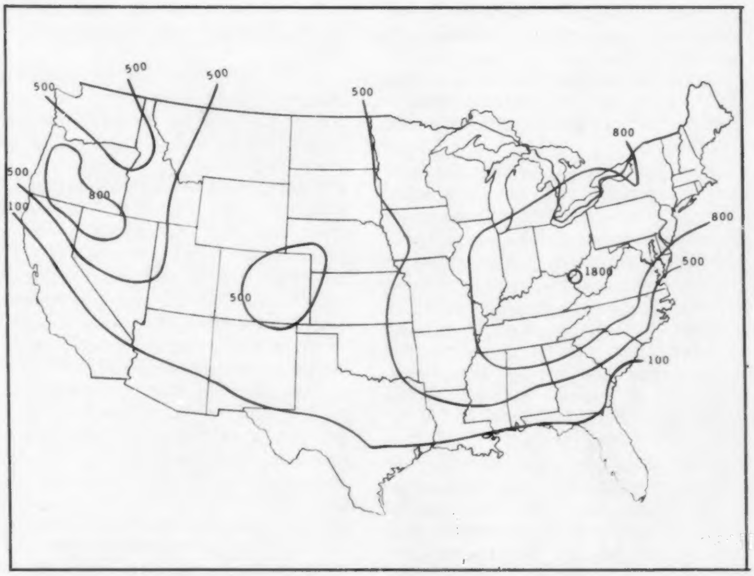


Fig. 1.—Map of "Weathering Index" Zones in the United States.

TABLE I.

	Total Annual Precipitation, in.	Winter Rain, in.
Pendleton, Ore.....	12.96	6.3
LaCrosse, Wis.....	28.92	5.03
Denver, Colo	14.06	7.6
St. Cloud, Minn....	24.16	2.0

A study committee of Subcommittee II on Brick and Structural Clay Tile of Committee C-15 considered several weathering criteria, which could be used to provide an analytical base for the waiver, or to define those climatological factors which produced significant frost action. These were: cycling of freezing and thawing, winter rainfall, number of rainy days, winter evaporation, and winter wind coincident with rain.

The study committee agreed that for the purpose the best criteria on which data are presently available are cycles of freezing and thawing and winter rainfall. Climatological summaries, published by the U. S. Weather Bureau, were analyzed for 100 weather stations. It was recognized that the only portion of precipitation which influences frost action is winter rainfall. The winter rainfall between the first fall freeze and the last spring freeze was computed for each station, and the number of cycles of freezing and thawing at 32 F were estimated from Weather Bureau data. The annual number of freezing cycles was taken to equal the difference between the mean number of days on which the maximum temperature was 32 F or less and the mean number of days on which the minimum temperature was 32 F or less. This difference would equal the annual number of freezing cycles, except for those days on which there was more than one cycle. The committee felt that the approximation is sufficiently accurate for the purpose. Winter rainfall for the freezing season was found by adding monthly totals and pro-rating the rainfall for those months in which the first and last freeze occurred. This approximation the committee also considered sufficiently accurate.

A Weathering Index

The "weathering index" for each locality was computed by multiplying

[1] 1956 Book of ASTM Standards, Part 3, p. 1973.

the winter rainfall in inches by the number of freezing cycles per year. The index is expressed, therefore, in inch-cycles per year. The map in Fig. 1 shows several "weathering index" zones for the United States.

The severity of frost action on brick is not directly proportional to the "weathering index." If two areas have the same number of freezing cycles, and one has more winter rainfall, the severity in that area is not necessarily greater. If a saturated brick is subjected to freezing, the addition of water will not result in greater or more severe weathering.

However, if two areas have the same winter rainfall, and one has more freezing cycles, the effect in that area on equally exposed brick is probably greater, provided the brick are wet when cycling occurs. If two areas have equal winter rainfall and equal temperature cycling at 32 F, the effect on equally exposed brick will be greater in the area having the greater number of rainy winter days, the probability being greater that the brick will be wet when cycling occurs.

If two areas have equal rainfall, equal freezing cycles, and number of rainy winter days, the effect on equally exposed brick will be greater in that area which has less evaporation, the probability being greater that the brick will be wetter when cycling occurs. All other factors being equal the effect of frost action on brick will be more severe where strong winds are coincident with rainfall, provided the brick are wet when cycling occurs.

Data on all of these variables are not available. For example, the Weather Bureau does not measure evaporation from a frozen pan. Data on evaporation at temperatures below freezing are, therefore, nonexistent.

The relationship of these weather variables to each other in such a way as to produce spalling of brick with varying degrees of quality and exposure is undetermined. The committee believes, however, that the product of winter rainfall and freezing cycles is an approximate index of the effect of frost action on brick in southern climates, and in any event bears a closer relationship to that effect than does total annual precipitation alone.

The effect of weather on brick of the same quality and use was observed in several Southwest cities, including Okmulgee, Okla., Shreveport, La., and Dallas, Austin, San Antonio, and Houston, Tex.

Laboratory absorption and compressive strength tests were made on several samples. It was found that grade NW brick with compressive strengths of more than 2500 psi, when used in a wall area exposed to the elements, spalled objectionably in North Texas and Oklahoma, but performed satisfactorily in southern Texas. In general, it was observed that such brick were not serviceable where the "weathering index" is greater than 100, but the ability of such brick to resist weathering in the Southwest bore no relationship to the total annual precipitation.

Empirically, then, the committee selected a "weathering index" of 100 or less as the criterion to define the geographical area within which a 2500 psi brick, regardless of its absorption or c/b ratio, might be used when exposed to weather. The waiver of 5-hr boiling absorption and saturation coefficient requirements and the substitution of a 2500 psi minimum compressive strength requirement within this geographical area has the effect of defining a quality of brick which may reasonably be expected to perform adequately.

The effect of this modification of ASTM C 62 was to reduce the area in which a brick, with no absorption or saturation coefficient requirements, may be used from 1,270,000 square miles of the western United States to an area of 334,000 square miles of the southern United States and to increase the minimum required compressive strength for that brick from 1500 to 2500 psi.

Fatigue Committee Well Represented in London

Of seventy papers presented at the International Conference on Fatigue of Metals, fourteen were written by members of ASTM Committee E-9 on Fatigue. The Conference held in London, England, September 10–14 was sponsored by the Institution of Mechanical Engineers (Great Britain) in cooperation with The American Society of Mechanical Engineers.

John M. Lessells, Joseph Marin, and Oscar Horger, all of Committee E-9, attended the conference where they also presented papers. Other E-9 members presenting papers were: T. J. Dolan, A. M. Freudenthal, H. J. Grover, E. C. Hartmann, B. J. Lazan, R. F. Broderick, R. E. Peterson, W. N. Findley, F. B. Stulen, J. A. Bennett, and G. M. Sinclair.

The sessions covered subjects such as stress effects, effect of temperature and environment, metallurgical aspects of fatigue, basic studies, engineering, and significance of fatigue. Because of the large number of papers at each session, authors did not present their papers in person. Instead, the European "reporter system" was used whereby reporters summarized all of the papers scheduled for the session. Thus a maximum amount of time was available for discussion.

A follow-up meeting of this Conference has been arranged by The American Society of Mechanical Engineers to be held in New York, November 28–30 where all of the United States paper will be given again. Complete sets of papers are available through the ASME Order Department.

A Highly Alkaline pH Standard

To increase the accuracy of pH measurements in the highly alkaline range, the National Bureau of Standards is recommending a sixth pH standard[1] for use along with the five pH standards previously established covering the pH range from 1.68 to 9.18 at 25 C. Consisting of a saturated solution of calcium hydroxide having a pH of 12.45, the new standard will provide an additional fixed point in the standard pH scale which the Bureau maintains.

The NBS standard pH scale is defined in terms of several fixed points in much the same manner as is the International Temperature Scale. The primary standards of the pH scale are solutions whose pH values are only slightly affected by dilution or by accidental contamination with traces of acid or alkali from the walls of the container or from the atmosphere. The substances from which the standard solutions are prepared are, in turn, stable materials which may be obtained as certified standard samples from the Bureau. The new highly alkaline standard fills a need which has been felt for several years.

The pH of the new standard solution—12.45 at 25 C—is a rather sensitive function of temperature. Values of pH on the NBS conventional activity pH scale have been assigned at intervals of 5 deg from 0 to 60 C. Although standard samples of calcium hydroxide are not yet available from the Bureau, highly pure preparations can be readily made from commercially available grades of calcium carbonate.

[1] For further details, see "Calcium Hydroxide as a Highly Alkaline pH Standard," by R. G. Bates, V. E. Bower, and E. R. Smith, *Journal of Research*, National Bureau of Standards, 56, 305 (1956) *RP 2680*.

Materials Tests—Source and Use

By K. N. Mathes[1]

An ASTM test method or specification often seems so simple and is used so routinely that little thought is given to what lies behind it. Some people attach a degree of finality or almost sacredness to an accepted test. Others tend to minimize the importance of or to deplore the use of a standard test as a serious limitation of freedom in design, development, or research. It is hoped that the fallacy of these latter opinions will be shown by careful review of how test methods and specifications are developed, interrelated, and should be interpreted and used.

The discussion is confined largely to insulating materials and plastics with some reference to associated materials such as textiles and adhesives so that the author can stay within the limits of his experience. The principles and ideas developed would seem to have broader applicability.

Definition

A variety of purposes of material tests may be involved either singly or in combination as outlined below.

Purpose of Material Tests:

1. Provide control in manufacture to:
   - Assure quality
   - Measure or allow control of properties
   - Provide a basis for customer acceptance and
   - Assure acceptance under consumers' specifications
2. Determine identity to:
   - Assure repeated purchase of materials previously found satisfactory in manufacture of use, and
   - Separate materials mixed or confused in storage, stock, or use (not necessarily a test of useful properties)
3. Provide control in use to:
   - Afford opportunity to change manufacturing process in using a variable material
   - Meet quality standards for manufacturing or ultimate use
   - Provide basis for rejection of substandard materials
   - Meet requirements or specifications of the purchaser or for ultimate product (often required by Government departments)
4. Permit evaluation of:
   - Suitability of new or different materials
   - Application development—new design and processes
   - Research

To be useful, a material test must meet one or more of the needs outlined above. Sometimes a single test may perform several functions—for example, control for the manufacturer and identity for the purchaser. Too often, however, the different character and purpose of the test is either misunderstood or ignored and it may be used inadequately or improperly. To better understand the problems involved, let us examine the source and development of materials tests.

Sources of Tests

Since tests for materials are developed to meet specific needs, it is not surprising that they come from many sources. In the first instance, tests are often directed to meet specific needs of a manufacturer or user of materials. Such tests may be kept secret if they afford a competitive advantage or if they might stimulate undesired purchase control or limitation of the manufactured product.

Most commonly, a test may be used as a basis for comparing materials used in commerce. Since the producer must usually meet the requirements of many customers, it is to his advantage to use standardized tests. Likewise the consumer wishes to use "standard" tests in order to avoid or minimize the appreciable time and cost of test developments as well as to capitalize on the accepted nature of the standardized test. Of course when tests are standardized, some individuality and specific applicability may be lost. For greatest usefulness, the "standard" must be developed by a generally accepted, competent group or organization.

Different groups may emphasize test *methods* or *specifications*. The distinction must be understood. *Methods* describe the way in which material properties are to be determined. *Specifications* set definite, acceptable limits for properties determined by the test methods. Obviously methods must be developed and accepted before specifications can be written.

The organization for standardization in the United States is complex. The following—though necessarily incomplete—outlines and describes the standardizing agencies of primary importance to insulating materials and plastics.

Manufacturers' Organizations:

- NEMA—National Electrical Manufacturers Assn.
- RETMA—Radio - Electronics - Television Manufacturers Assn.
- SPI—Society of the Plastics Industry

These organizations emphasize specifications but include test methods by reference or by description if necessary. Standards which can be met by competent manufacturers are encouraged. In many instances, comment and approval of consumer interest is sought—most often through other branches of the same organization.

Consumers' Organizations:

- Governmental agencies such as the Armed Services
- Underwriters Laboratory
- EEI—Edison Electric Institute
- AEIC—Association of Edison Illuminating Co.
- American Association of Railways

These organizations, like those of manufacturers, also emphasize specifications. As a rule, they develop test methods to meet the needs of their specifications only when methods are unavailable from other sources. The intent is to obtain specifications which will guarantee property values meeting at least the minimum accepted needs of the sponsoring members. Producers often believe that consumer specifications are unrealistic and constitute mere "wishful thinking." In some instances it is claimed that consumers' specifications cover such broad areas as to be meaningless for particular materials or that in specific applications they do not represent functional needs. On the other hand, consumers should be expected to understand their own needs best and many have well staffed and equipped laboratories.

Engineering or Scientific Organizations:

- AIEE—American Institute of Electrical Engineers
- ASME—American Society of Mechanical Engineers
- IRE—Institute of Radio Engineers
- SPE—Society of Plastics Engineers
- ACS—American Chemical Society

The primary purpose of the engineering and scientific societies is to advance the technology of their individual interests. Activity of the individual

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[1] Mr. Mathes is insulation systems engineer, General Engineering Laboratory, General Electric Co., Schenectady, N. Y. This paper is part of a presentation made for Molecular Engineering—a 1956 summer session at the Massachusetts Institute of Technology.

rather than his company, university, or organization usually predominates. A major emphasis is placed upon the presentation and correlation of scientific data. To a greater or lesser degree, however, the different organizations develop codes, procedures, or standards. Emphasis if usually placed upon the general aspects but in some instances specific test methods or specifications are developed; particularly, if it is apparent that technological need is not being met by the activities of other groups.

Producer-and-Consumer Organizations:

ASTM—American Society for Testing Materials
ASA—American Standards Assn.
IEC—International Electrotechnical Commission
ISO—International Standards Organization

These organizations provide equal opportunity not only to consumers and producers but also to a very significant third group—often called "General Interest." This category includes educational organizations, privately sponsored research, development, and testing laboratories, as well as the exceedingly important National Bureau of Standards.

The special position of the American Standards Assn. deserves comment. This top coordinating standards body does not as a rule develop standards but rather provides for submission of standards by other member organizations. These standards are accepted by the member bodies which represent all of the organizations described previously. The final product then is approved as an *American* Standard.

Just as the ASA provides coordination in the domestic area, the international organizations coordinate international standards. The United States Committee to the IEC functions through the ASA, which also provides contact with the ISO. The IEC and ISO maintain liaison and have established jurisdiction in specific areas through historical development, priority, and activity.

On the other hand, ASTM actually develops test methods and specifications. A clear distinction is made between methods and specifications. Needed test methods are developed and are referenced in the specifications. Some adverse criticism has been directed at ASTM's activity in writing specifications. The prerogative seems established without question, but the appropriateness of specification development probably should be examined in each particular case.

The outstanding criticism directed at ASTM concerns the seeming near impossibility of obtaining worthwhile agreement from participants with very diverse interests. The consequent slowness in some instances in the development of standards and their subsequent application is irksome. This somewhat justified criticism is, of course tempered by the usefulness of ASTM activities, test methods, and specifications.

Selection of Tests for Different Purposes

It may be useful to consider the principles to be used in selecting tests for different purposes. A general outline of the purpose of material tests has been given above under the heading "Definition." Using this outline, a number of principles can be advanced for developing and selecting needed methods and specifications.

Control in Manufacture

Tests should directly or indirectly measure properties significant in application and use, for example, color, only if color is important. In manufacture of insulating material, the customer's actual needs must be met effectively and honestly, but he must occasionally be persuaded to eliminate tests he *thinks* he needs, but doesn't.

Control tests should be designed to be as rapid and simple as possible to permit effective process control. Automatic sampling or continuous measurement may be applicable and needed.

Specification values should be designed to meet needs but not unrealistically reject production. Statistical methods are useful (see ASTM Manual on Quality Control of Materials (*STP 15C*) and Special Technical Publications on Statistics). In the final analysis a problem of cost is involved. Perhaps more attention should be given to the production of different grades of materials at different prices to meet different needs.

Determine Identity

Often materials can be accepted by manufacturers' qualification test or simply on his reputation and reliability. In this case only identity tests are needed, for example, flash point to characterize solvent, etc. In this case test methods and specification values need not be related to functional properties. An identifying characteristic such as color, density, or hardness may be selected. Pure identity tests must not be confused with or used as evaluation tests but they may sometimes be used as a control test in a specific instance where they can be related to functional needs.

Control in Use

All of the comments made under "Control in Manufacture" are applicable for "Control in Use." In addition, tests may be needed to select material batches particularly suitable for difficult manufacturing processes or applications. For example, it may be necessary to select materials with particularly high resistivity to serve as insulation in an ion chamber. Similarly, the measurement of property values may permit variations in processing to compensate for product variations. As an example, the number of layers of tape in a heavy insulation build might be varied to allow for changes in the thickness of individual tapes.

Evaluation in Application of Materials Designs and Processes—Evaluation in Research—Pure or Applied

Tests for evaluation constitute a broad and difficult area of use. Evaluation needed for application of a new material may well differ markedly from the evaluation needed in research on the same material. It is important to emphasize that tests useful in application or research may or may not be useful in control or identity. Control or identity tests likewise are seldom useful—at least without modification—in evaluation for application effort or research.

As an example, possible research and application effort on a hypothetical heat-resistant film can be considered. Infrared analysis might be used to show changes in structure—cross linking, carboxyl group formation, etc.—as a function of aging at different temperatures in oxygen, as contrasted to aging in nitrogen. Such tests could provide information on chemical mechanisms vital to research but relatively unimportant in application. Tests measuring loss of strength or elongation during heat aging in air would be more appropriate in application evaluation, since results of such tests can be related to needs in use. (These tests in turn might not be as suitable for research.)

As contrasted to control or identity tests, tests used for evaluation often require that measurements be made as a function of another variable—time, voltage, temperature, etc. In some cases it has been difficult to obtain ASTM recognition of such needs, probably because many of the ASTM committee members are concerned only with control or purchase-specification problems. On the other hand, individuals interested in application and research have often failed to take

advantage of ASTM activity and have not recognized the tremendous advantage of adopting or adapting proved ASTM methods and techniques to their specific purposes.

The adaptation of tests for evaluation in research and application deserves special consideration. The details of a test method must not be considered sacred and invariable. The purpose of the test must be kept in mind. For example, the method of Test for Water Absorption of Plastics (D 570)[2] calls for water immersion of 2 and 24 hr. This test might be modified for evaluation to include liquids other than water. For some purposes weight increase as a function of time over several months or longer might be evaluated. Several water temperatures might be used and leaching effects might be determined by alternate immersion and drying. Even more important, other tests, such as dimensional change, electrical properties, tensile strength and elongation, might be made and correlated with the weight increase. On the other hand, the analytical balance used in the ASTM water-absorption method might not meet the sensitivity required in research and a Chevenard balance or other more suitable equipment might be needed.

In every instance the purpose and need for evaluation must be considered carefully, broadly, and without bias occasioned by previous experience or notion. The ability to utilize previous experience constructively in new areas without bias is extremely valuable and only too seldom realized.

Relationship of Materials Tests to Design, Manufacturing, and Service Requirements

A basic purpose in tests used for application evaluation and to some extent in research involves "usefulness" of the tests. Tests on materials cannot be relied upon alone.[3] The interrelationship of various types of tests—the "ladder" of evaluation—is shown in Table I. The greatest significance can be obtained from these tests when they are developed keeping their interrelationship in mind. Obviously, tests on materials cannot have as complete a significance as actual life in service or as tests on complete equipment. But tests on materials can be developed and evaluated with results of service failures and tests on complete machines in mind. In the opposite direction, field failures that are often difficult to interpret may often be understood better after tests are made on the materials used. Tests on materials permit understanding of chemical or physical mechanisms which control properties and associated changes. It is easier and less expensive to make tests on materials than to test complete machines or learn with failures in service.

Tests often can be made on simple combinations of materials in order to attain greater significance in terms of use. In a sense, varnished cloth is a combination of cloth and varnish and more significance is realized by testing the combination rather than the untreated cloth and varnish separately. It is conceivable even that three-part combinations might be considered as simple combinations. For example, hydrolytic degradation in Mylar may be evaluated by heat aging a combination of Mylar and paper sealed with an insulating varnish. So far ASTM has not progressed far in the development of tests for simple combinations of insulating materials, although their prerogative to do so seems clearly established. In fact, unless ASTM accelerates markedly in this direction, the initiative will have been seized by other groups like the Committee on Dielectrics of the AIEE, which has recognized the need and is already actively at work.

By "running up and down" the evaluation ladder of Table I, the importance and usefulness of tests on materials will undoubtedly become more apparent to design and construction engineers as well as to the users of equipment. Too often engineers have said, "Maybe tests on materials can be used for control, but they mean nothing to design or service." Too often, also, they were right, but progress is being made. For example, in the area of the rating of electrical equipment and the associated temperature classification of materials, engineers are finally coming to realize the importance of functional tests.[4]

Summary and Conclusion

ASTM tests cover tremendous scope and can be very useful. But no test, including those of the ASTM, can be used blindly. The more intelligent and experienced the effort directed to interpretation and use, the more useful and significant will be the results. Many gaps in tests to meet pressing needs can be pointed out. The only answer lies in adequate effort by devoted but also competent individuals, properly selected and adequately supported by the sponsoring companies and organizations.

Throughout, a dominant principle, which is important in the development, interpretation, and use of tests, should be emphasized—*purpose and end use must be kept in mind.* All too often it is difficult to tell whether or not a test is useful for identity, control, or evaluation—for what material or kinds of material it can be used—or for what application purpose and under what conditions it can be used. Often individuals or groups with narrow or restricted viewpoints develop tests or specifications with the same restrictions, often without realizing the limitations.

ASTM through its emphasis on significance of statements is helping to answer the problem. In Committee D-9 on Electrical Insulating Materials, a subcommittee is assigned the task of emphasizing the problems of significance and coordinating the approach to its solution.

The increasingly rapid development of new materials and equipment with new and difficult demands on materials emphasizes and makes more urgent the need for adequate test methods and specifications. Without minimizing the great importance of research and development on materials, processes and equipment, it is not an overstatement to say that tests and specifications for control and evaluation of the materials are as equally necessary for technological progress.

TABLE I.—THE EVALUATION LADDER.

Service Life
Tests on Complete Equipment
Tests on Component Parts
Tests on Simulated Systems
Tests on Simple Combinations of Materials
Tests on Materials

[2] 1956 Book of ASTM Standards, Part 6, p. 362.

[3] K. N. Mathes, "Functional Evaluation of Insulation Materials," *Transactions*, Am. Inst. Electrical Engrs., Vol. 67, p. 1236 (1948).

[4] K. N. Mathes, "Principles for the Temperature Classification of Insulating Materials by Functional Test," *Electrical Engineering*, March 1954.

Random Samples...

FROM THE CURRENT MATERIALS NEWS

From the broad stream of current materials information flowing from "in-box" to "out-box" in a busy editorial office, random samples (mostly random) have been plucked. Thinking them worth re-showing to ASTM'ers who may have missed the original articles, we have included them here. Of course, we had to trim the samples to fit. There will be those who are not satisfied with samples, especially ones which are not really random. But these ASTM'ers can contact the institution, magazine, governmental agency, etc., who placed the original information in the stream, or address Random Samples, ASTM, 1916 Race St., Philadelphia 3, Pa.

Big Squeeze

A METALWORKING milestone has been reached by Aluminum Company of America with production of the world's largest closed-die forging.

The record-making aluminum part, a massive 3000-lb airframe member, is being produced on the Air Force's giant 50,000-ton press. As it comes from the dies, the huge piece measures 13 ft in length, 3 ft across at its widest point, and 1 ft in thickness.

Produced for the Martin Co., the pace-setting forging will be part of the airframe in the XP6M SeaMaster, the world's first multijet seaplane. It will help form the backbone of the fuselage and wing structure in the radically designed four-jet aircraft.

Achievement of the king-size forging makes possible a substantial weight reduction and a consequent increase in the performance level of the SeaMaster. It offers, in one unit, a part formerly assembled from many smaller components. Elimination of the previously required joining operations will mean savings of both time and money in production of the Martin plane.

Before the forging could be attempted, the Cleveland works die shop had to accomplish another first by sinking the world's largest dies. Working from Martin Co. specifications, Alcoa formed plaster models of the proposed big dies. Because of their exceptional size, the models had to be made in two sections to minimize distortion. Each was mounted, in turn, on a die sinking machine. Electrical impulses, transmitted by a tracer arm following the contours of the models, guided the machine's cutting tool to etch the dies.

From a set of rough forged, armorplate steel die blocks weighing 75 tons, a set of 60-ton finished dies was produced. Some 15,000 lb of metal were machined from the blocks prior to mounting on the die-sinking equipment. The remainder was whittled away during the actual sinking operation, and in the milling of key and toe-clamp slots.

Engineering and production of the enormous dies required several months, with sinking and finishing operations for each die consuming 1500 man-hours.

The huge press squeezed the big forging from a 4200-lb blank in alloy X7079. This high-strength alloy, developed by Alcoa, imparts high mechanical properties, by heat treating, not previously possible in heavy sections.

Wedding Announcement

A NEW product, combining the structural strength of steel with the rich decorative effects of vinyl plastic in an almost limitless variety of colors and textures has graduated from the Research Laboratory and is now in experimental production at U. S. Steel's Irvin Works in Dravosburg, near Pittsburgh, Pa.

Cold-reduced sheets are coated with liquid plastic to produce an appealing, tough-surfaced sheet of great beauty and durability. It promises new decorative effects and long service in such equipment as refrigerators, radio and TV cabinets, wall panels, automotive bodies and trim, stove and heater parts, railroad coach, club, and sleeping car interiors, office and home furniture.

In the process of manufacturing, the steel is surface-treated to improve its bonding qualities, a specially compounded adhesive is applied to the top surface and then cured by heating. After air cooling, the steel enters a coating chamber where the thermoresponsive vinyl plastic is applied to the adhesive-coated surface. Again, heat is applied to solidify the plastic. Prior to cooling, the vinyl coating is embossed to obtain the desired design or texture. The finished product is stacked by a magnetic piler.

The coating of this new material has excellent abrasion resistance and good electrical resistance properties. It is unaffected by humidity and many chemicals. The coating also produces sound-deadening effects similar to that

obtained by "muffle coating" automobile bodies and will have value in acoustical design. The new product, which can be supplied in any standard color, can be utilized for manufacturing many parts which heretofore required protective or decorative finishing after fabrication, such as automotive panels, radio and television cabinets, institutional and office furniture, appliances, kitchens, wall panels, etc. Elimination of the need for such postfabrication treatment, coupled with the unique properties of the new coated sheet, will result in lower production costs, together with superior wearing qualities and decorative effects.

At present, due to the developmental nature of the operation, no definite annual production capacities have been established. The pilot-line facilities at the Irvin Works will produce 18- to 28-gage sheets 24 to 52 in. wide. The semicommercial product is being offered for sale on a developmental basis.

Radiation Exposure Levels Revised

SINCE its establishment in 1928, the International Commission on Radiological Protection has had the responsibility of setting the working levels of ionization radiation to which all persons may safely be exposed.

When the Commission's work began, there was little thought that its findings and recommendations would play so important a part in the international picture of radiation use. It was fortunate, indeed, that its first recommendations on permissible exposure, made in 1934, were able to provide the guide lines for protection.

Work of the ICRP has been closely paralleled by that of the U. S. National Committee on Radiation Protection (NCRP), which was formed in 1929. The two groups have substantial overlapping of membership on their subcommittees which, in turn, are formed along similar lines. In fact, a part of the present International Recommendations on Radiological Protection follows the pattern set by the NCRP.

The 1934 recommendations on permissible exposures were based mainly on the possible harm to the individual working with X-rays. Virtually no thought was given to possible genetic effects. However, as a result of the intensified study of this question during the Manhattan District days, and new evidence which indicated the possibility of both genetic effects and long-range effects on the individual, a review of these questions was made by both the national and international commissions. In 1948, the NCRP recommended that the permissible levels of radiation exposure be reduced by a factor of about 2. Thus the permissible exposure of 0.1 roentgen per day was lowered to 0.3 roentgen per week. The same basic figure was subsequently adopted by the ICRP in 1950.

Since 1950, it has become increasingly clear that larger fractions of the population will be exposed to radiation from both medical and atomic-energy sources. It therefore became paramount to reassess the whole protection problem, and to take into account the newer evidence on possible long-range genetic effects and possible shortening of individual life-span due to radiation exposures. The ICRP took up these problems at Stockholm in 1952, and its latest recommendations again provide for a degree of lowering of the permissible exposure.

It is proposed that a lowering be achieved without changing the basic level of 0.3 roentgen per week. If this maximum level were maintained indefinitely, it would mean an exposure of about 15 roentgens a year, or between 400 to 600 roentgens per working lifetime. The Commission has agreed that exposure of a substantial fraction of the population to this much radiation is undesirable. Accordingly, while adhering to the permissible exposure of 0.3 roentgen per week, the latest recommendations of the ICRP state that it is inadvisable for an individual to receive more than 50 roentgens up to his age of 30, 100 roentgens up to age 40, and 200 roentgens up to age 60. This means that individuals who are exposed to radiation at the maximum levels will be allowed to work only one-third of the time. In effect, the normal daily working level is reduced by a factor of about 3.

This will not be as difficult to carry out as might at first appear, since most of the large atomic energy and other radiation establishments in this country are already operating at exposure levels considerably below even the new reduced amount. It is rare for individuals in such operations, even today, to be exposed to more than about one-fifth of the present permissible amount.

The new recommendations will, however, introduce a penalty on those installations that insist upon exposing their workers to the maximum permissible weekly amount. Under the new rules, such workers may be exposed to this level for only one-third of their working time, the penalty thus taking the form of intermittent and hence uneconomic use of personnel. The inducement will therefore be strong for such installations to improve their protection facilities to the point where the maximum radiation exposure will not exceed the newly recommended average levels.

The Bookshelf

High-Temperature Technology, Materials Methods and Measurements

Edited by I. E. Campbell, John Wiley and Sons, Inc., New York, N. Y., 526 pp., $15.

THIS book, whose publication was sponsored by the Electrochemical Society fills an important gap in the technical literature. High-temperature technology is a field which does not fit neatly in any of the engineering disciplines, such as metallurgical or ceramic engineering, but transcends several of them. It is therefore not surprising that there are several books on the metallurgical or ceramic aspects of the field but none which covers it in its entirety.

The Electrochemical Society has been particularly active in sponsoring symposia on high-temperature technology. These symposia have clearly shown the need for a comprehensive treatment of the field in book form and have resulted in the present volume.

As the subtitle indicates, the three principal sections of the book are on materials, methods, and measurements. The sections are divided into a number of chapters, each of which was written by an authority in the particular subject. The contributions to each section were edited by section editors and the entire book was then edited by I. E. Campbell, chief of the Division of Inorganic Chemistry and Chemical Engineering at Battelle Memorial Institute. The three principal sections are preceded by a brief introduction which points out the importance of high-temperature materials in today's technology and the principal problems which are encountered in the use of these materials.

The chapter headings of the section on materials are: Metals, Oxides, Carbon and Graphite, Carbides, Borides, Silicides, Nitrides, Sulfides, and Cermets. Since the original aim of the book was to limit the discussion to service at temperatures above 1500 C, the chapter on metals is confined to a brief review of the metallurgy of tungsten, molybdenum, tantalum, and niobium, which have melting points above 2400 C and are not classed as noble metals.

In the other chapters of the section on materials, more complete surveys are presented. While some of the chapters, as for instance the one on silicides, merely present a listing of literature references, other chapters attempt a critical sifting of the literature, clearly pointing out what is known about the materials and where there are gaps in our knowledge. The chapters on oxides and on cermets appear to be particularly comprehensive.

The chapters in the section on methods with the exception of the first are concerned with the practical problem of achieving high temperatures. Only the first chapter is theoretical in nature and makes an attempt to clarify the mechanism of sintering, that is, the consolidation of materials under the influence of temperatures and pressures insufficient to cause melting. The second chapter of the section briefly surveys the various methods of obtaining high temperatures and their limitations while in the rest of the chapters specific designs of furnaces are described. These include a split tungsten-tube vacuum furnace, Geller's oxide resistor furnace, a hot pressing resistance furnace developed by the Norton Co., an arc furnace for melting titanium and zirconium, solar furnaces, and an electronic torch.

The chapters in the last section of the book treat the measurement of high temperatures themselves and of mechanical and physical properties at high temperatures. The concluding chapter describes the techniques of microscopy and X-ray diffraction at high temperatures. Both the theory and the practice of pyrometry by radiation methods are surveyed exhaustively, and the possibilities of measuring high temperature with thermocouples are critically reviewed. The discussion of mechanical property determinations at high temperatures, on the other hand, is limited to a description of specific designs of a creep-testing machine developed at the University of Michigan for temperatures between 1300 and 1900 C, a torsion testing machine, and a hot hardness testing machine both developed at Armour Research Foundation. In the chapter on physical properties the theories underlying the measurement of vapor pressures and of thermal shock are well presented. Practical details are given for measuring these two properties as well as thermal and electrical conductivity and thermal expansion at high temperatures.

As the editor points out in his preface, numerous compromises were necessary in selecting material for this monograph. In a field of technology which is so rapidly advancing, it is perhaps inevitable that certain subjects were to be treated in more or less exhaustive surveys, while others are represented by descriptions of individual designs. Nevertheless, this book will be of inestimable value to the many engineers and scientists who are concerned with high-temperature technology in one way or another.

FRITZ V. LENEL

Air Force Materials Research

PB 111648S, Mary M. Sokas, Wright Air Development Center, U. S. Air Force, 137 pp. $3.50. Order from OTS, U. S. Department of Commerce, Washington 25, D. C.

Two hundred and five reports of research conducted under the Air Force's materials research and development program from July 1, 1954 to June 30, 1955 are abstracted in a publication just released through the Office of Technical Services, U. S. Department of Commerce.

The publication contains abstracts of research in adhesives, metallurgy, analysis and measurement, biochemistry, textiles, petroleum products, plastics, packaging, protective treatments, and rubber.

This publication is supplementary to two other volumes, also available from OTS, of the same title: PB 111648, price $2.75, covering Air Force materials research from July 1, 1953 to June 30, 1954; and PB 111537, price $3.75, covering the 10 years of research prior to July 1, 1953.

Automotive Antifreezes

IN 1923 the National Bureau of Standards issued a leaflet on automotive antifreezes as a means of answering the increasingly large correspondence on this subject. The Bureau had earlier initiated a significant engine antifreeze testing program for various Federal agencies. These tests included not only laboratory investigations, but actual service tests as well.

Early in these investigations the Bureau found that salt-base antifreezes severely corroded metallic parts of the engine regardless of the use of inhibitors. Petroleum-base antifreezes destroyed radiator hose and were a serious fire hazard. Much work has since been done on methyl and ethyl alcohols and ethylene glyol.

The latest edition of National Bureau of Standards Circular 576, reviews the conclusions reached by the research of the Bureau into the properties and utilization of engine antifreezes to date.

F. L. Howard, D. B. Brooks, and R. E. Streets, National Bureau of Standards *Circular 576*, Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.; 15 cents.

A Study of Rheological Testing of Elastomers at Low Temperatures*

By C. K. Chatten, W. E. Scoville, Jr., and F. S. Conant

Nine types of rheological tests in the general categories of creep, stress relaxation, and recovery and set.

THE Low-Temperature Correlation Section of Subcommittee 27 of ASTM Committee E-1 on Methods of Testing was established in March, 1951 to study existing test methods used in measuring the stiffness, brittleness, hardness, and rheological properties of elastomers and plastics at low temperatures, to determine if any correlation exists among these methods and to perform additional laboratory work required to complete this study. Final reports on stiffness (**1**)[1] and hardness (**2**) have already been published, and a report on brittleness is being prepared. The present report covers rheological properties.**

Low-Temperature Rheological Tests Studied

A program outline of rheological testing of elastomers and plastics was approved at a meeting held in April, 1954. The methods to be studied[2] and the significant factors of each are given in Table I. As shown in Table I, the tests were divided into three general groups: (1) creep or strain relaxation methods, (2) stress relaxation methods, and (3) recovery or set methods. The list does not include all of the applicable tests; they were selected either because they were representative of the more generally used tests or simply because the tests could be readily performed with the equipment available in almost any rubber laboratory.

Creep

A tensile strain procedure (method A) was compared with a torsional strain procedure (method B) in measuring the strain of materials under conditions of constant stress. The creep was calculated from values of strain measured at various intervals of time.

Tensile Creep (method A)

The apparatus consisted of a thermoregulated low-temperature cabinet containing a mounting rack from which the specimens were suspended and lower grip and weight assemblies for stretching the specimens by dead weight loads. Specimens were cut from each of the four 0.075-in. thick sheet stocks with a type D die conforming to ASTM Method D 412.[3] In performing a test, specimens of each stock, after scribing with 1-in. bench marks, were suspended in the mounting rack and conditioned for 30 min at the selected temperature of exposure. The lower grips and weights were then attached to the respective specimens and the distance between the bench marks was measured after 3 min as the initial strain, L_0, and again after 1, 22, 46, 70, and 94 hr, L_t. The amount of dead weight (approximately 5 lb) suspended from the lower end of each specimen was adjusted to produce a specimen stress of about 533 psi based on the original cross-section area of the specimen. Creep was plotted *versus* time in two ways. In method No. 1, the creep was plotted as a per cent change in elongation as noted in the chart, Table I. In method No. 2, the measured values of specimen elongation were plotted directly, starting with the original bench mark (unstretched) length of the specimen. This test was performed, either completely or in part, by laboratories 1, 2, and 3.

Torsional Creep (method B)

The Clash-Berg instrument specified in ASTM Method D 1043[4] was selected for this test and the instrument was used in the working chamber of a thermoregulated low-temperature cabinet. In conducting a test, a strip specimen, 0.075 in. thick by 0.50 in. wide by $2\frac{1}{2}$ in. long ($1\frac{1}{2}$-in. free length), was mounted in the instrument clamps and conditioned for 30 min at the selected temperature of exposure. An appropriate amount of dead load was then added to each of the instrument loading pans. This load was sufficient to produce a torque of 0.052, 0.156,

NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* The opinions and assertions in this paper are the author's and are not to be construed as official or reflecting the views of the Naval Service at large or of the industrial laboratories concerned.

** This is the third in a series of four articles prepared under the sponsorship of Subcommittee 27 of ASTM Committee E-1, task group on correlation of test methods. This article is a condensation of two original reports written by C. K. Chatten and W. E. Scoville upon completion of extensive tests by the participating laboratories. The article includes an analysis prepared in consultation with other members of the Correlation Section. It deals with rheological properties and is based on data contained in a subsection report (**3**) presented during ASTM Committee E-1 meetings held in Atlantic City, N. J., on June 29, 1955.

[1] The boldface numbers in parentheses refer to the references appended to this paper.

[2] Many of the tests selected for study were those described in a bibliography prepared for the use of Subcommittee VI on Packings, and Subcommittee XVII on Tests of Hardness, Set and Creep, of ASTM Committee D-11, on Rubber and Rubber-Like Materials. Copies of this bibliography are available on request.

[3] Tentative Method of Test for Tension Testing of Vulcanized Rubber (D 412 – 51 T), 1955 Book of ASTM Standards, Part 6, p. 1129.

[4] Method of Test for Stiffness Properties of Nonrigid Plastics as a Function of Temperature by Means of a Torsional Test (D 1043 – 51), 1955 Book of ASTM Standards, Part 6, p. 195.

CLARENCE K. CHATTEN has been head of the Elastomers Development Section, Material Laboratory, New York Naval Shipyard since 1942 specializing in development of instruments and methods for evaluating elastomer materials. Before that, from 1932, he was engaged in compound development in the laboratories of two industrial rubber companies.

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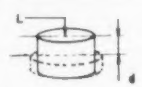
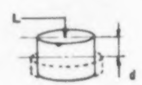
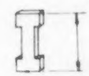
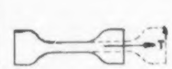
F. S. CONANT has been engaged in physics research at The Firestone Tire and Rubber Co., Akron, Ohio, since 1943. His chief interest has been in the field of low-temperature properties of elastomers.

W. E. SCOVILLE, JR., assistant development manager, Passaic Plant, U. S. Rubber Co., Mechanical Goods Division, has been, since 1934, working on packing, heavy molded goods, and belts.

TABLE I.—THE SIGNIFICANT FACTORS OF RHEOLOGICAL PROPERTIES IN TESTING OF ELASTOMERS AND PLASTICS (WITH SPECIAL REFERENCE TO LOW TEMPERATURES).

Creep or Strain Relaxation Methods	Stress Relaxation Methods	Recovery or Permanent Set Methods	Test Machine Used	Readings Unit of Measure	Results Expressed as	Samples: Size or Cut	Samples: Shape and Force	Alternate Equipment	Stress or Strain Applied and Manner: Tension	Compression	Torsion	Shear	Conditioning Time: Before	Test	Formula
A—Mare Island stiffness	....	....	Dead weight	Change in length, 0.01 in.	Change of elongation, per cent	$3\frac{1}{32}$ ±0.002 × 1 in. dumbbell—$\frac{1}{16}$ 0.002 in. thick. Sub. 27. (Use type D tension specimen 0.075 in. thick)		(I) NBS strain tester (II) Monsanto	533 psi.	....	...	...	2 hr.	3 min	Psi $= \frac{W}{A_0}$ Creep $= \frac{L_t - L_0}{L_0} \times 100$
B—Clash-Berg D-1043	....	....	Torsion twist	Angular twist, deg	Apparent modulus of rigidity, psi.	$2\frac{1}{2}$ long × 0.25 in wide × 0.040–0.125 in. thick. Sub 27. (Use strip specimen 0.500 ± 0.0002 in. wide × 0.075 ± 0.005 in. thick)		U. S. Rubber torsion test	...	....	Dead weight equal to 0.052 to 2.2 in./lbs on $1\frac{1}{2}$ in. span	...	D-618	3 min initial and as desired	$G = \frac{917TL}{ab^3 \cdot u\phi}$ or Creep $= \frac{\phi_t - \phi_0}{\phi_0} \times 100$
	C—Hopolog (MacDonald)	....	Parallel plates	Change in strain of deflection plate, microinches	Per cent of original stress of specimen	1.129 ± 0.001 in. diam. × 0.500 + 0.005 in. thick. −0.025 in.		(I) Material lab strain gage tester (II) Government lab strain gage tester	...	To 44 duro, 40 per cent deflection. 45 to 64 duro, 30 per cent deflection. 65 to 84 duro, 25 per cent deflection. 85 duro and over 20 per cent	...	...	22 hr or 94 hr	Initial and as desired	$R = \frac{S_0 - St}{S_0} \times 100$
	D-Tobolsky (Firestone)	....	Beam loaded	Change in load, lb.	Stress, psi. *versus* unit log time	$2\frac{11}{16}$ OD × $2\frac{5}{16}$ ID ring 0.028–0.054 in. thick. Sub 27. (Use T-50 specimen 2 in. long × 0.075 ± 0.005 in. thick)		Material lab tensile stress decay apparatus	100 per cent elongation	....	...	...	15 min before stressing	Initial and as desired	$R = \frac{S_0 = St}{S_0} \times 100$
		E—Comp set D-1229[a]	Parallel plates	Deflection, 0.001 in.	Per cent of original deflection	1.129 ± 0.001 in. diam. × 0.500 in. ±0.005 in. thick. 0.025 in.		...	...	To 44 duro, 40 per cent deflection. 45 to 64 duro, 30 per cent deflection. 65 to 84 duro, 25 per cent deflection. 85 duro and over 20 per cent	...	...	22 hr or 94 hr	10 sec or 30 min	$C = \frac{t_0 - t_{10}}{t_0 - ts} \times 100$ *or* $C = \frac{t_0 - {}_{30}}{t_0 - ts} \times 100$
		F—Comp set "A" D-395[b]	Parallel plates	Deflection, 0.001 in.	Per cent of original thickness	1.129 ± 0.001 in. diam. × 0.500 ±0.005 in. thick. 0.025 in.		...	...	400 psi.	...	...	22 hr or 70 hr	30 min	$C = \frac{t_0 - t_1}{t_0} \times 100$
		G—T-R retraction D-1329[c]	Clamping rack	Length, in. ±0.03 in., at 2 min. (2 C) intervals	Temp. at 10, 30, 50 and 70 per cent retraction	T-50 specimen 2 in. long and 0.075 × 0.075 in. cross-section		...	50 per cent and 250 per cent elongation	....	...	...	10 min before releasing	−70 C up 2 min (2° C) intervals	Per cent retraction $= \frac{Le - Lt}{Le - L_0} \times 100$
		H-Tensile set D-380[d]	Clamping rack	Change in inches, 0.01 in.	Per cent of original length	ASTM—412 die C $\frac{1}{16}$ to $\frac{1}{8}$ in. thick. Sub 27. (Use specimen 0.075 in. thick)		...	50 per cent and 250 per cent elongation	....	...	...	3 hr	2 min hold, 2 min rest	$ps. = \frac{Lt - L_0}{L_0} \times 100$
		I—Shear recovery	Recovery from dead weight loading	Deflection, 0.0001 in.	Recovery, per cent	Double shear sandwich. Each half $\frac{1}{4}$ in. thick, $\frac{3}{8}$ in. wide, $3\frac{3}{4}$ in. long		...	...	....	...	28.5 psi	16 hr under load at room temp	30 min at each test temp	Per cent recovery $= \frac{Rt - Re}{R_0 - Re} \times 100$

0.677, and 2.2 lb-in. for natural rubber, GR-S, vinyl, and polyethylene, respectively. The stop pin was released and an angular deflection reading was made 3 min after applying the load. This reading was regarded as the "initial" reading, ϕ_0, in calculating percentage values of creep. The load was allowed to act on the specimen for the duration of the (94 hr) exposure period at a particular temperature, ϕ_t. As before, creep was plotted *versus* time in two ways. In method No. 1, the percentage values of creep were plotted. In method No. 2, the absolute values of angular deflection were plotted beginning with zero angular deflection (no torque load on the specimen). This test was performed, in part, by laboratory 2 only.

Stress Relaxation

A relaxation procedure employing compressive stress (method *C*) was compared with one employing tensile stress (method *D*) in measuring the decrease in stress of the materials due to internal relaxation under conditions of constant strain. Alternate methods to the ones listed in Table I were used. These (alternate) methods were proposed by the Government Laboratories, University of Akron, and the Material Laboratory, New York Naval Shipyard, respectively. Relaxation was calculated as a ratio of the stress loss measured after any time interval to the initial stress value.

Stress Relaxation in Compression (method C)

The stress decay device used in this test was developed by the Government Laboratories, Akron, Ohio. It utilized a load cell incorporating a strain-gage circuit for measuring stress of a specimen held under essentially constant strain. This instrument is similar to those described by MacDonald, Labbe, and Chatten (**4,5,6**). Compression set specimens 1.129 in. diameter by 0.50 in. thick were compressed in the device at room temperature, 30 per cent compression in the case of GR-S and 40 per cent in the case of natural rubber. The assembly was then immediately placed in a thermoregulated chamber maintained at the desired low temperature of exposure and a stress reading was taken 30 min afterwards. This 30 min reading was regarded as the initial reading, S_0, in calculating subsequent values of stress decay from stress readings, S_t, obtained during the 94 hr specimen exposure period. Stress decay, in per cent, was calculated in accordance with the formula given in the chart, Table I. This test was performed, in part, by laboratory 4 only.

Stress Relaxation in Tension (method D)

A tensile relaxation test, developed by the Material Laboratory (**7**), was employed in lieu of the Tobolsky method referred to in Table I. In conducting a test, a T-50 specimen 1 in. long was mounted in a rack and elongated 100 per cent after which the rack was secured in a position vertical to the framework of a support stand. Then a Dewar flask containing alcohol regulated to the desired exposure temperature was positioned under the rack and elevated to immerse the elongated specimen. An initial specimen stress reading, S_0, was made 1.2 min after the start of the exposure period. The load, measured with a Hunter force indicator, was read at the instant of break in electrical contact between the upper specimen mount and the support stand proper. After making the initial stress reading, the rack containing the elongated specimen was removed from the support stand and transferred, while still in the Dewar flask, to a low-temperature cabinet operating at the same temperature. Then, the racked specimen was removed from the flask within the cabinet for further conditioning in cold air. Additional stress readings, S_t, were made in the same manner periodically during the course of the low-temperature exposure period. Stress relaxation, in per cent, was calculated by the formula given in Table I. This test was performed, in part, by laboratory 2 only.

Recovery and Set

Procedures employing compressive strain or stress (methods *E* and *F*), tensile strain or stress (methods *G* and *H*), and shear stress (method *I*) were compared with each other in measuring the residual deformation of materials after removal of the deforming stress or strain condition. With the exception of the T-R test, the values of recovery and set were calculated from measurements of deformations produced under conditions of constant stress or strain. In the case of the T-R test, the results were expressed as the temperature at which the specimen had retracted a given amount.

Compression Set, Constant Deflection (method E)

The test was made as specified in ASTM Method D 1229[5] except that the assembled jigs were placed in the low-temperature cabinet 30 ± 3 min after assembly (not just any time within the 30 min period). Compression set specimens 1.129-in. diam by ½-in. nominal thickness were used. The percentage compression set, both 10 sec and 30 min after disassembly of the jig, were calculated as specified. The test was performed completely or in part by laboratories 1, 5, and 6.

Compression Set, Constant Load (method F)

Spring loading jigs as described in ASTM Method D 395[6] and standard size compression set specimens were used in the test. Each jig, containing a compression set specimen under a 400-lb spring load, was placed in the low-temperature cabinet 30 ± 3 min after loading. At the end of the designated exposure period each jig, in turn, was unloaded in the low-temperature cabinet and the recovered thickness of the specimen was measured 30 min afterwards at the temperature of the test. The per cent compression set was calculated as specified in Table I. The test was performed in part only by laboratories 1 and 5.

Temperature-Retraction, T-R (method G)

This test was performed in accordance with the procedures specified in ASTM Method D 1329.[7] In the case of natural rubber and GR-S, separate sets of specimens were elongated 50 per cent and 250 per cent before placing them in the low-temperature bath. Vinyl specimens were tested at 50 per cent elongation only. No evaluations were made on polyethylene. The T-R test was performed by laboratories 3, 4, and 7.

Tensile Set (method H)

Type *C* tension specimens were bench marked L_0, elongated the specified amount and held in the stretched condition in suitable jigs. At a time 30 ± 3 min after elongating the specimens, the respective jig assemblies were placed in a low-temperature cabinet for conditioning at the selected (low) temperature. Tests on natural rubber and GR-S were made at specimen elongations of 50 per cent and 250 per cent whereas tests on vinyl were performed at 50 per cent specimen elongation only. No evaluations were made on polyethylene. At appropriate intervals during the exposure period (from 30 min to 94 hr), sets of specimens were released from the jigs and recovery measurements were made, L_t at the temperature of the test, both 10 sec and 30 min afterwards. The tensile set test was performed by laboratory 3 only.

Shear Recovery (method I)

The apparatus consisted essentially of a means of applying shear stress to a double sandwich-type specimen so that observations could be made of the specimen deformation as the test conditions were varied (**8**). The specimens used (Hevea and GR-S) were based on the same compounding formulas and cures as the specimens utilized in tests by methods *A* through *H*. They were of the double shear sandwich type, each half being ¼-by ⅜-in. cross-section and 3¾ in. long. In performing a test, the specimen was allowed to remain under 80 lb (28.5 psi) load for 16 hr at room temperature and then cooled, while still under load, to −80 F, thus producing a state of essentially equilibrium deformation. The load was then removed and the progressive recovery, *R*, was noted for 30 min after which the load was reapplied and the specimen temperature was raised to the next higher temperature. Another recovery reading was obtained and then the test was repeated at still higher temperatures of exposure. This test was performed by laboratory 8 only.

General Plan of Test

Samples of a Hevea gum compound, a GR-S tread type stock, a plasticized vinyl material, and polyethylene were prepared by the same laboratories that supplied samples for the hardness, stiffness, and brittleness programs. The

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[5] Method of Test for Low-Temperature Compression Set of Vulcanized Elastomers (D 1229 – 55) 1955 Book of ASTM Standards, Part 6, p. 1053.

[6] Method of Test for Compression Set of Vulcanized Rubber (D 395 – 55), 1955 Book of ASTM Standards, Part 6, p. 1047.

[7] Tentative Methods for Evaluating Low-Temperature Characteristics of Rubber and Rubber-Like Materials by a Temperature-Retraction Procedure (TR Test) (D 1329 – 54 T), 1955 Book of ASTM Standards, Part 6, p. 1191.

compounds were chosen simply because they provided for coverage of a wide range of stiffness and stiffening temperatures. A single laboratory cut sets of specimens from the sample compounds provided and forwarded them to the several laboratories participating in the study, Table II.

TABLE II.

Participating Laboratory	Test Performed
No. 1 E. I. du Pont de Nemours & Co., Inc., Polychemicals Dept., Research Division, Wilmington, Del.	Methods *A*, *E*, and *F*
No. 2 Material Laboratory, Naval Shipyard, Brooklyn, N. Y.	Methods *A*, *B*, and *D*
No. 3 United States Rubber Co., Mechanical Goods Division, Passaic, N. J.	Methods *A*, *G*, and *H*
No. 4 Government Laboratories, University of Akron, Akron, Ohio	Methods *C* and *G*
No. 5 Armstrong Cork Co., Research and Development Center, Lancaster, Pa.	Methods *E* and *F*
No. 6 B. F. Goodrich Co., Research Center, Brecksville, Ohio	Method *E*
No. 7 Phillips Petroleum Co., Phillips, Tex.	Method *G*
No. 8 Firestone Tire and Rubber Co., Chemical and Physical Research Laboratories, Akron, Ohio	Method *I*

Specific specimen exposure temperatures ranging from room temperature (74 F) to −80 F and exposure times ranging from 30 min to 94 hr were designated. The tests were made and the data were calculated by the methods specified.

Test Results

A summary of the results of tests conducted by the eight participating laboratories is shown in the figures referred to below:

TABLE III

	Figures
Creep Methods:	
Tensile (*A*)	1 through 5, and 1A, 2A, 3A, 5A
Torsional (*B*)	6 through 9, and 6A through 9A
Stress Relaxation Methods:	10, 11
In compression (*C*)	12, 13, 14
In tension (*D*)	
Recovery and Set Methods:	
Compression set, constant deflection (*E*)	15 through 20
Compression set, constant load (*F*)	21 22 through 26
Temperature-retraction (*G*)	27 through 33
Tensile set (*H*)	34
Shear recovery (*I*)	

In these figures each point on the curves shown in broken lines represents an average value, usually of three determinations, reported by a single laboratory. Points on curves shown in solid lines represent the average value calculated from results reported by two or more laboratories.

Analysis

Creep

As shown in the figures, misleading conclusions regarding the magnitude of creep might be drawn by an examination of results expressed only as percentages of "initial" reference strain values obtained after an arbitrary time interval. Therefore, the measured readings of creep, in inches, by method *A* and in degrees of angular deflection by method *B* were also plotted. From these curves it is readily apparent that, in most cases, by far the greater amount of specimen distortion occurs before the "initial" strain value is recorded. In addition, the initial strain of the materials differs markedly. For example, in the study of method *A*, initial strain of the Hevea sample under the applied stress was approximately twice that of the GR-S; it was about three times that of the vinyl, and was as much as a hundred or more times greater than the polyethylene. Thus, those materials that undergo a large initial distortion at the test temperature obviously have a large number in the denominator of the fraction used in calculating percentage creep. Then, if further specimen distortion is relatively small, the numerator in the fraction will be small as will be the percentage values of creep calculated therefrom. Conversely, materials that show a relatively small amount of distortion at the time the "initial" strain value is recorded would, assuming a further reasonable increase in strain, generally show quite large percentage values of creep. This latter apparently anomalous situation is illustrated by the curves for Hevea rubber in tests by method *A*. The relatively low strain of polyethylene under the applied stress accounts for its inconsistent creep behavior. Polyethylene, at this stress, does not show the same magnitude of creep as the Hevea, GR-S, or vinyl samples; in fact it appears to belong to a distinctly different class of materials ductile in nature with a definite yield point.

The foregoing remarks are generally true in the case of torsional creep tests made by method B. However, insufficient data were obtained in these tests to show the effect of specimen exposure time on rate of creep. The relative distortion of the specimens was not as severe as for the tension creep procedure used in method *A*. Creep was greatest for the plastic (as compared with elastomer) materials because of the greater torsional load applied.

Relaxation

The amount of prestrain imposed on specimens in tests by method *C* was roughly an inverse function of their moduli. For example, a lesser strain was applied to the GR-S than to the lower modulus Hevea material. Therefore, in this respect, the materials did not have the same starting point, either stress or strain. A more desirable but possibly impracticable procedure would be to compress the specimens a sufficient amount to produce the same (instantaneous) stress reading in all tests. Also, the time at which the "initial" stress readings were taken was chosen arbitrarily. This was 30 min after initial compression of the specimens. Thus, as in the case of creep tests, a better utilization of the compression stress relaxation data might be obtained if more suitable "initial" stress values could be obtained by practical means.

The values of tensile stress relaxation determined at 100 per cent specimen elongation in tests by method *D* show that, over the temperature range explored (room temperature to −20 F), by far the largest amount of relaxation of the GR-S and vinyl stocks occurred during the first few seconds of the strain period. Also, since stress relaxation is expressed as a ratio of stress changes to the initial stress, the magnitude of the "initial" modulus has a marked effect on the values of stress relaxation calculated therefrom. Consequently those stocks that are temperature sensitive and therefore show a high "initial" modulus at a particular low temperature generally exhibit proportionally higher relaxation.

Recovery and Set

In comparison with creep and relaxation tests, the method *E* constant deflection test is a static one. In method *E*, the specimen is under a constant strain and no measurements are made of changes in stress or strain during the course of the specimen exposure period; all measurements are made after removal of the deforming strain condition. Gross differences in specimen modulus are roughly compensated by imposing a greater strain on relatively soft elastomer materials than on the harder materials. Time considerations are important only when making measurements of specimen recovery at the end of the low-temperature exposure period. Some inconsistencies in data are noted in these tests, especially in the case of natural rubber evaluated at −60 F for the 10-sec recovery period and at −80 F for the 30-min recovery period.

All specimens evaluated by method *F* were compressed under the same stress (400 psi) in all tests as compared with

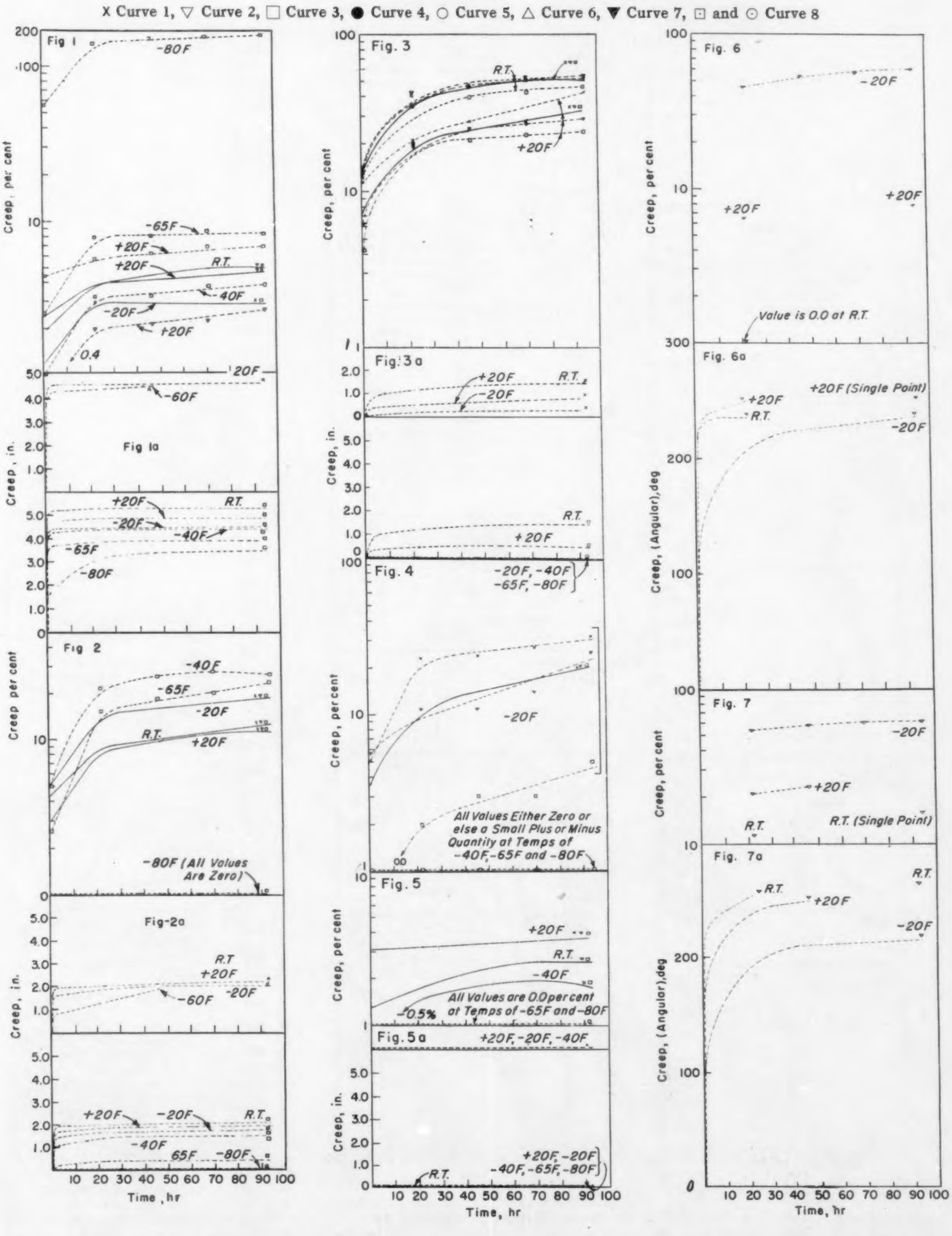


Fig. 1.—Creep—Method *A*—Natural Rubber. Fig. 2.—Creep—Method *A*—GR-S. Fig. 3.—Creep—Method *A*—Vinyl. Fig. 4.—Creep—Method *A*—Vinyl. Fig. 5.—Creep—Method *A*—Polyethylene. Fig. 6.—Creep—Method *B*—Natural Rubber. Fig. 7.—Creep—Method *B*—GR-S.

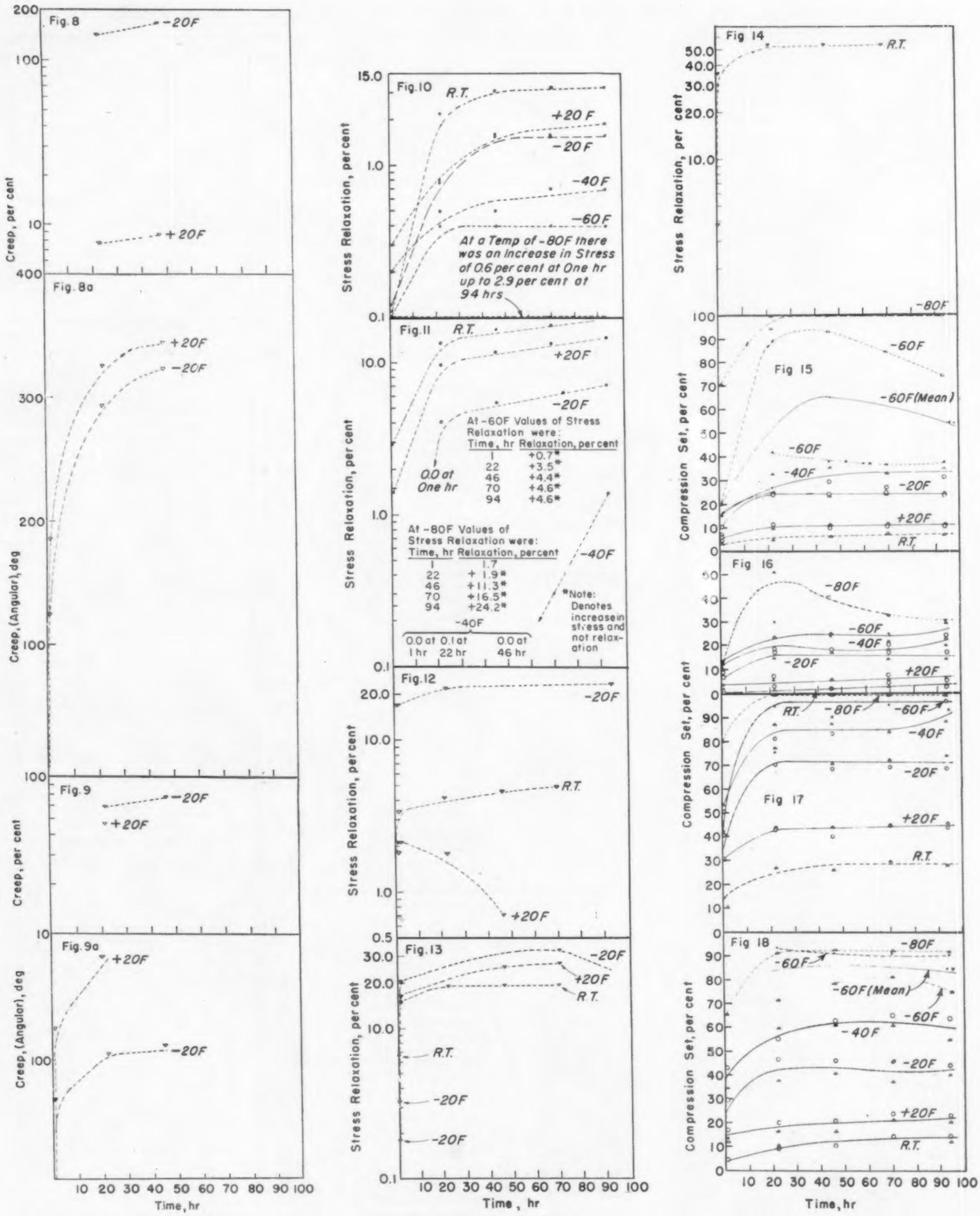
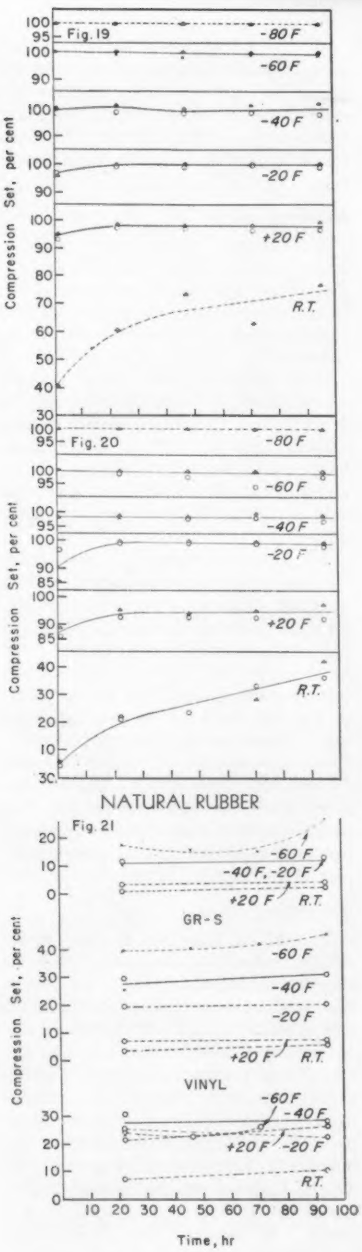
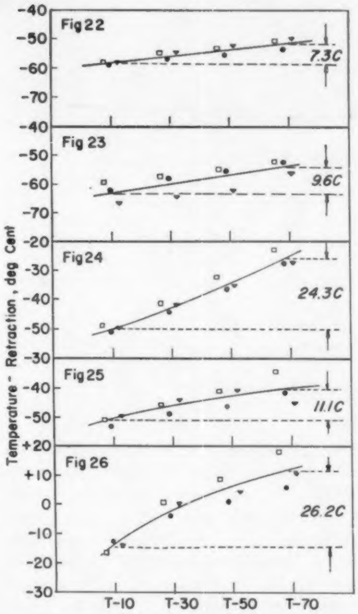
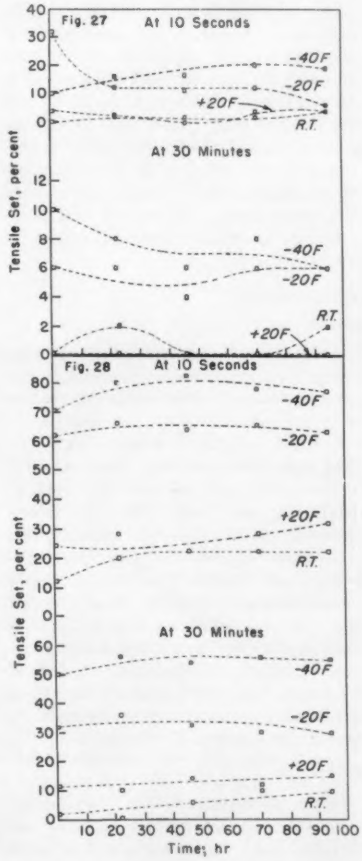


Fig. 8.—Creep—Method *B*—Vinyl. Fig. 9.—Creep—Method *B*—Polyethylene. Fig. 10.—Stress Relaxation—Method *C*—Natural Rubber. Fig. 11.—Stress Relaxation—Method *C*—GR-S. Fig. 12.—Tensile Stress Relaxation—Method *D*—Natural Rubber (100 per cent Specimen Elongation). Fig. 13.—Tensile Stress Relaxation—Method *D*—GR-S (100 per cent Specimen Elongation). Fig. 14.—Tensile Stress Relaxation—Method *D*—Vinyl (100 per cent Specimen Elongation). Fig. 15.—Compression Set—Method *E*—Natural Rubber (10 sec Reading). Fig. 16.—Compression Set—Method *E*—Natural Rubber (30 min Reading). Fig. 17.—Compression Set—Method *E*—GR-S (10 sec Reading). Fig. 18.—Compression Set—Method *E*—GR-S (30 min Reading).







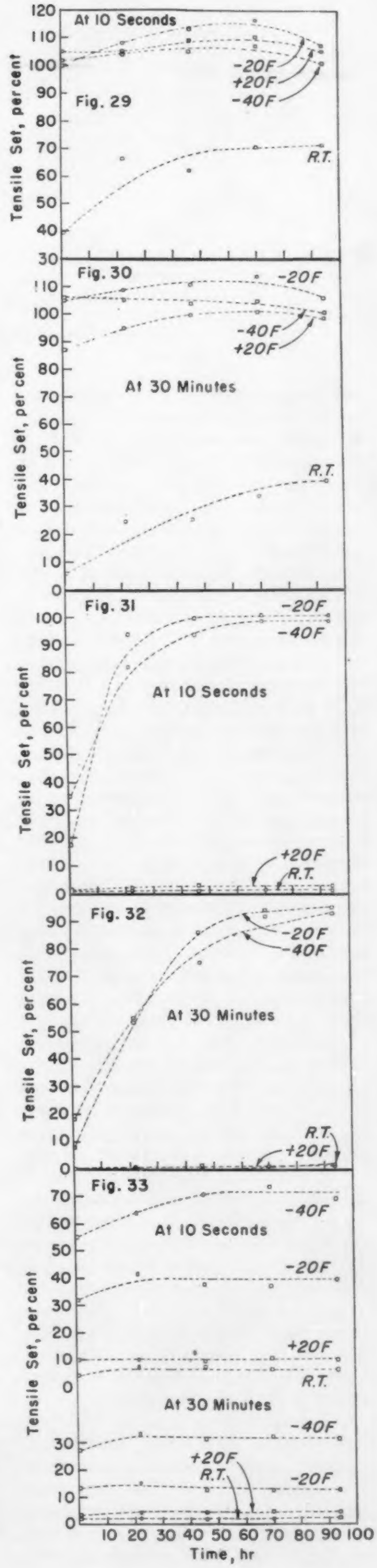


Fig. 19.—Method *E*—Vinyl (10 sec Reading). Fig. 20.—Method *E*—Vinyl (30 min Reading). Fig. 21.—Method *F*. Fig. 22.—Method *G*—Natural Rubber (50 per cent Specimen Elongation). Fig. 23.—Method *G*—Natural Rubber (250 per cent Specimen Elongation). Fig. 24.—Method *G*—GR-S (50 per cent Specimen Elongation). Fig. 25.—Method *G*—GR-S (250 per cent Specimen Elongation). Fig. 26.—Method *G*—Vinyl (50 per cent Specimen Elongation). Fig. 27.—Method *H*—Natural Rubber (50 per cent Specimen Elongation). Fig. 28.—Method *H*—GR-S (50 per cent Specimen Elongation). Fig. 29.—Method *H*—Vinyl (50 per cent Specimen Elongation). Fig. 30.—Method *H*—Vinyl (50 per cent Specimen Elongation). Fig. 31.—Method *H*—Natural Rubber (250 per cent Specimen Elongation). Fig. 32.—Method *H*—Natural Rubber (250 per cent Specimen Elongation). Fig. 33.—Method *H*—GR-S (250 per cent Specimen Elongation).

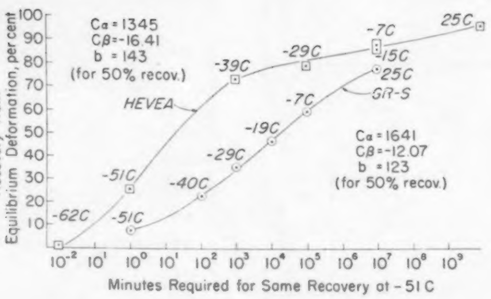


Fig. 34.—One-Minute Recovery—Method *I*.

only roughly equivalent stresses imposed on specimens in tests by the constant deflection procedure of method *E*. Although the method *F* tests did not include the entire range of specimen exposure times and temperatures, no significant inconsistencies in the data were obtained as in the case of compression set tests made by method *E*.

The effect of the degree of strain on the low-temperature recovery properties of elastomers is illustrated in tests by method *G* (temperature-retraction). For example, in the case of GR-S, the T-70 value averaged −40 C at 250 per cent specimen elongation and −26 C at 50 per cent elongation. The T-10 value, however, averaged −50 C for both elongations. The effect of elongation on Hevea was less pronounced, probably because Hevea stiffens over a narrower temperature range than does GR-S. Method *G* differs from all the other rheological tests studied in at least two fundamental respects: (*a*) the test temperature is changed during the specimen recovery period, and (*b*) the recoveries do not start from the same strain at the different temperatures.

The tensile set test performed by method *H* is similar in principle to the compression set test of method *E* in that the specimens are distorted a specified amount and the degree of recovery is measured at the temperature of the test at a specified time after removal of the deforming strain. Although the tensile set test performed as described in this article does not take modulus effects into consideration, the results show a rough correlation with those obtained in the compression set tests. The inconsistent data yielded in tests at 50 per cent specimen elongation are attributed mostly to errors in reading the specimen retraction at small elongations.

In method *I* (shear recovery) the free recovery from essentially equilibrium deformation was measured as a function of the recovery time. The data were normalized for Jourle effect by using the equilibrium deflection at each test temperature as a base in calculating percentage recovery. The composite curves obtained illustrate the fact that essentially 100 per cent recovery would eventually take place at any test temperature. The fundamental measurement, then, is the temperature at which a given recovery takes place in a given time; or the recovery which takes place in a given time at a given temperature. A commonly used index is the temperature at which 50 per cent recovery occurs in one minute. For Hevea this was at −49 C (−56 F) and for GR-S it was −15 C (+5 F). These indices show a greater difference in low-temperature rheological behavior between Hevea and GR-S than do most of the other tests. The vinyl and polyethylene materials were not tested by method *I*.

Conclusions

Creep

Care must be exercised in analyzing creep data expressed as percentage figures of "initial" reference strain values obtained after an arbitrary time interval. Strain of most elastomer and plastic materials changes rapidly at the start of a creep test, and the amount of initial strain may be widely different from one material to another. Consequently, percentage figures of creep calculated from these "initial" reference strain values may provide misleading information. A better interpretation of the data may be obtained by studying the measured changes in specimen strain recorded during a test, starting with zero strain at the instant of application of load to the specimen.

Relaxation

Stress relaxation data are ordinarily expressed as percentage figures of "initial" load values measured at constant specimen strain after some arbitrary time interval. Therefore, like creep tests, the results obtained are influenced by the modulus of the material and the rate at which the material attains elastic equilibrium. An ideal relaxation test would be one in which the specimens are deformed an amount sufficient to produce approximately the same "initial" stress in all tests and which uses as the "initial" reference stress value the highest reading obtained during application of strain.

Recovery and Set

The degree of recovery attained within a given time after removal of a distorting force from a specimen at low temperature is dependent upon both the equilibrium modulus and the relaxation time. The equilibrium modulus is directly proportional to the absolute temperature (Joule effect), while the relaxation time decreases in a nonlinear manner with increase in temperature. Both variables are functions of the strain, which fact probably explains at least a part of the inconsistency in the data.

It appears from the data obtained in this study that tests in the three basic categories, that is, creep, relaxation, and set (or recovery), do not rate the low-temperature suitability of elastomer materials in the same order. None of the tests provides a universal parameter for comparison of the low-temperature rheological properties of different elastomers. Thus, the engineer or rubber technologist who requires design data on elastomer materials intended for low-temperature service must choose the type of test that most nearly simulates the expected service condition.

Acknowledgments:

Typical of most work done under ASTM sponsorship, this assignment was completed through the cooperative efforts of a large number of individuals and laboratories. F. M. Gavan of the Armstrong Cork Co., chairman of the Low-Temperature Correlation Section of Subcommittee 27 of ASTM Committee E-1, guided the work from its inception. R. H. Carey of the Bakelite Co. and B. G. Labbe of the University of Akron Government Laboratories prepared the sample stocks used in the study. L. Boor of the Philadelphia Quartermaster Depot and A. C. Webber of du Pont de Nemours & Co., Inc., provided technical consultation during the course of the study. In addition to the authors, who participated in the work by performing tests, as listed in Table II, F. M. Gavan, B. G. Labbe, A. C. Webber, R. Shearer of the B. F. Goodrich Research Center, and J. F. Svetlik of the Phillips Petroleum Co., collaborated in this project. Other contributors were T. A. Werkenthin of the Navy Department, Bureau of Ships, and R. S. Havenhill of the St. Joseph Lead Co., chairman of Subcommittee 27 of ASTM Committee E-1 under whose auspices this work was performed.

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Judgment and Environment Factors in Soil Investigations

By Donald M. Burmister

Editor's Note.—Soil is a material unique in character and varying in composition and arrangement; thus the testing of soil is not a simple operation. Professor Burmister, Department of Civil Engineering and Engineering Mechanics, Columbia University, has long been concerned with the indiscriminate use of the results of standard soil tests by many practicing engineers. ASTM Committee D-18 on Soils for Engineering Purposes has supported this concern and has endorsed the publication of the pertinent thoughts expressed in this article.

IN ALMOST twenty years of activity of Committee D-18 on Soils for Engineering Purposes, notable progress has been made and the committee has achieved wide recognition for its work. These have been years of exploring possibilities, of growing understanding, and of developing ideas of soil testing. The purpose of this paper is to suggest fundamental ideas, conceptions, and approaches and to direct thought toward higher scientific levels.

Appraisal of Present Situation

With increase in knowledge, understanding, and experience there has inevitably come the realization that soil phenomena are more complex and more difficult to comprehend and to explain than originally supposed. But there is a disturbing aspect in the present situation, namely, a tendency to give more emphasis to so-called practical expediencies in present conceptions and practices—which in the nature of things must be transient in character—than to the development of fundamentals and principles. This has resulted principally from the pressure exerted by engineering practice for immediate simple empirical rules for practical applications. Along with scientific advances there is a growing, general but incompatible acceptance and use of broad generalizations, empiricism, rough approximations, and oversimplified conceptions and practices.

Soil classification has grown out of the idea that it was simpler and more practical to group soils into broad generalized classes than to identify individual soils precisely on the basis of their recognizable and determinative characteristics. But classification has remained the most confused aspect of soil mechanics. This confusion is inherent in the shortcomings and limitations of the idea and practical workings of classification as applied to soils because it attempts to put into a single "package" oversimplified conceptions and generalizations of both soil character and soil performance, without regard to controlling conditions (**5**,**6**).[1]

The acceptance and use of the standard test approach has arisen from the belief of many engineers that an analogous simple treatment of soil testing is a valid approach, particularly in highway and embankment construction. Resemblance here is only superficial, since standard soil testing is predicated on the premise that there is an essential simplicity and identity of soil responses in standard tests and under actual field conditions without regard to environmental influences.

The emphasis on empirical correlations and approximations has grown out of the idea that soil phenomena are too variable and complex to permit any rational theoretical treatment. It has been argued that theoretical developments offer little that is relevant in establishing ordered physical laws of soil behavior.

The acceptance and use of these expediencies in dealing with a material such as soils has resulted in attempts to fit each new advance into the accepted scheme. This attitude has tended to set the level of attainment in soil mechanics. It should be realized, however, that scientific knowledge is a body of statements of varying degrees of certainty.

Fundamental Ideas and Conceptions

Each new advance in soil mechanics should bring about a re-evaluation of all related aspects. Emphasis should now be on developing fundamental knowledge and principles, and on greater

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

thoroughness and comprehension. Conceptions of adequacy should be consistently revised to keep pace with scientific advances. Attitudes and conceptions are of prime importance since they predetermine the adequacy and quality of judgments and practices, and hence the reliability and usefulness of soil investigations for design and construction of foundations and earthworks. Thus certain ideas may be added to previous discussions on this subject (**1**,**3**,**4**).

That the character and responses of soils are inherently variable and complex products of geological processes and of the natural environment is a fundamental factor. These responses vary with the character and susceptibility of soils. New conditions imposed by construction methods and sequences and by structures and service conditions cause important changes in the influences of the environment. Changes in soil responses are inevitable, in contrast to the specified uniformity of the common structural materials, the predictability of their behavior, and the constancy of their properties and responses. Soils are unusual engineering materials and should not be expected to follow the same patterns of behavior as structural materials.

The soil engineer should understand completely the character and range of environmental influences, their relative dominance, soil susceptibility, and identifiable characteristics and properties, the kind and degree of modification caused by construction of structures, and how and to what degree conditions can be improved. These are the major aspects of soil mechanics. They can be established within each person's experience and practice.

Soil tests should reflect and evaluate the influences of environmental and imposed conditions upon soil responses. Unfortunately, the results of standard soil tests in their present form, using a single average test procedure for each method of test, cannot usually be translated into reliable and significant predictions of soil responses. This is a consequence of the fact that the measured responses and properties themselves are changed from the original "in place" state by the very procedures and test conditions used.

The controlling influences of the environmental and imposed conditions on soil responses are so complex in their interaction and control that they can be determined and evaluated reliably only by soil tests which represent and reproduce these conditions. It is necessary to learn what "being representative" really means in each situation, and how it may be attained in soil testing. This requires an appraisal of the controlling conditions in each situation and an evaluation of their influence on soil responses. If the test conditions are not representative of a situation, then the measured responses of the soils are certain to be modified and hence inapplicable for interpretation since there are no absolute or standard responses of soils for reference (**5–11**).

The above approach is of the nature of "simulated service testing" (**2**), which has demonstrated its practical value and worth to industry. This idea has been recognized by ASTM as an important present trend. Some of Mr. Gordon's thoughts on simulated service testing (**2**) are summarized as background and guidance in applications to testing soils.

> Where environment and resulting responses influence performances and life, the test is more difficult to set up and the approach is entirely different. The reliability of test results depends on how completely the conditions are known with regard to scope and character and how closely they can be duplicated. The conditions set up must be reproducible in the laboratory and must bear resemblance to actual conditions. The philosophy is not to seek empirical correlations, but guidance in selecting conditions and in setting up such tests. Because of the complexities involved in programming the environmental conditions and in conducting the test, it is necessary to guard against a strong tendency to oversimplify the requirements, and to end up with a constant-environment test at some average or severe condition. This procedure automatically nullifies the influences of the environmental variable, and in many cases gives results not applicable to actual service.

In view of these fundamental conceptions, the use of single all-purpose standard soil test procedures, of oversimplified classification, and of empiricism without regard to actual controlling conditions, cannot now be justified. They adversely introduce ignorance factors and elements of uncertainty into soil investigations by being unrepresentative in unknown and uninterpretable ways. Hence the important and controlling aspects in a situation cannot be clearly recognized or properly evaluated. The results can be deficient and even misleading in important aspects, and hence they do not provide adequate bases for judgments in soil investigations and for decisions on design and construction of foundations and earthworks. This condition should no longer be tolerated in practice. There are important questions of adequacy and professional ethics involved which should be given thoughtful and conscientious consideration.

Principles of Soil Testing

The basic problems of soil testing are those of reconciling the influences of the natural environment and of the artificial environment in a test in order to obtain comparable and representative responses, which have valid applications in predicting field performances. What is urgently needed, as a realistic approach and attitude, are "Standards of Controlled Environment Testing of Soils" (**8–11**). The fundamental principle here involves the conditioning of each specimen in a soil test by restoring and reproducing, as closely and representatively as possible, the original environmental conditions, and by imposing in sequence, the controlling conditions to be imposed by the construction of structures. Controlled environment test methods can provide a basic framework of principles for each method of test, which is not only flexible and permits a wide latitude in test conditions, but also is capable of improvement fully in keeping with scientific advances.

The modification of test procedures does not mean that the basic framework of a method of test is to be altered, but rather that certain modifications of test procedures are used to make them more representative of a specific situation. In many cases these modifications may be relatively simple, as a common sense approach.

There seems to be prevalent an idea concerning modifications with regard to "permissible variations in test procedures" and corresponding "permissible deviations in test results." This places an undue and unrealistic emphasis on the permissible aspect, as if there were established standards of responses for each method of test. It does not give proper emphasis to the fact that soil tests should be made representative of specific conditions. The test of "being representative" is really that of being adequate—not whether variations in procedures affect or cause variations in results. No short-cut test procedures can be expected to be representative, especially where time-delay phenomena control responses. Soil is a material which is strongly influenced by natural environmental conditions and is equally influenced by the artificial conditions imposed in a soil test. The purpose of modifications of test procedures is to bring about such changes in soil responses in accordance with the conception of "being representative."

By applying the principles of controlled environment test methods, soil

test procedures can be made to reproduce and to reflect specific conditions that control responses. Judgment factors enter soil testing in programming, selecting appropriate test conditions and modifications, and in carrying out soil tests with the required technical skill and understanding. This approach involves the basic attitudes of consistently seeking to understand and to interpret more correctly the conditions that control, of learning how to translate these conditions into test conditions, and of developing the techniques for conducting fully representative soil tests to meet the requirements of these conceptions. This is realistic soil testing and is a work of discovery to disclose, evaluate, and bracket the range of soil character and specific controlling environmental influences. This imposes the essential requirement of at least two answers representing probable bracketing limits. Averages of test results can be misleading, because they tend to penalize the favorable aspects and to obscure the unfavorable aspects inherent in a situation. Representative soil testing does, however, involve acceptance of responsibility for adequacy of results.

The basic problem confronting ASTM Committee D-18 on Soils for Engineering Purposes is to explore these ideas and to fit them into a coherent system which is sufficiently useful and convincing to be generally accepted (**1**,**11**). The preparation of an adequate scope is most essential. It should include not only statements of the uses and limitations of a method of test but also recommended practice with emphasis on what "being representative" means in a particular method of test. It should convey the fundamental concept that any modifications of test procedures should be made only on the basis of making soil responses and test results as representative as possible of a particular situation.

In addition, the principal environmental influences and imposed conditions that govern soil responses in a particular method of test should be listed and defined, so that they may be appraised properly (**1**,**8**). The report of results of every soil test or group of tests should include statements on the environmental and imposed conditions which were considered to control and of the test conditions which were selected as representative, so that the test data may be properly interpreted and evaluated.

Fundamental Approaches

The essential place of soil testing in soil investigations should be recognized. The five fundamental steps in making specialized investigations of bearing values, settlements, and stability of foundations and earthworks are: (1) adequate subsurface soil explorations and sampling of soils and reliable, representative and complete records of conditions encountered; (2) accurate and complete identifications of soil material and natural soil structure to disclose the determinative characteristics of soils (**6**,**7**); (3) fully representative soil testing to disclose the fundamental responses of soils under the conditions that control (**8–11**) (all contain examples of responses of soils to such conditions); (4) significant ratings of soils with regard to their potential favorable and unfavorable aspects and susceptibility, as a basis for interpreting and making effective use of soil data (**5**,**10**,**11**); and (5) complete evaluations of the influences of inherent conditions, as a reliable basis for predicting the probable actual responses of soils (**1**,**8**,**9**,**10**,**11**).

These fundamental steps in soil investigations are intimately interdependent. Each is determinative in all succeeding steps. Deficiencies, ignorance factors, and uncertainties at any stage always tend to affect adversely the adequacy of the final results. The essential attitude that should now govern conceptions and practices is to make the results of soil investigations, as a work of discovery, more revealing, reliable, and practically useful.

A serious shortcoming in practice is the tendency to treat these interdependent steps as unrelated operations, those carrying out separated steps seldom having adequate information for their work. To eliminate the possibilities of deficiencies and unrepresentative results, the conditions that control in the situation should be given careful consideration and be evaluated in conference by all parties concerned, so that each has a clear picture of the problems involved. No soil testing should be undertaken without such information and knowledge. Then, either those performing soil tests must be capable of translating this information into representative soil testing conditions or this essential information on soil testing procedures and modifications must be supplied by those requesting the soil tests, with each accepting his share of responsibility for the representative character and adequacy of test results. This is placing soil testing on a properly higher plane of adequacy and value.

The major aspect of soil investigations for engineering works under these conceptions is to disclose and to evaluate the nature and relative importance of the favorable and unfavorable aspects inherent in a situation by representative soil testing and ratings of potential behavior. Full advantage can be taken of all favorable aspects, and the unfavorable aspects can be improved by proper evaluations of the conditions that control. Foundation design can be more closely fitted to actual existing conditions. Safe limits and time sequences can be established for construction of foundations and earthworks. Thus it would be possible to realize high standards of excellence and significant economies in the planning, design, and construction.

The most important step for the future in realizing these standards of excellence in practice and these practical engineering objectives is: "To treat real soils under influences of essential real and representative conditions that control."

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Nitrided Chromium for Wear Applications

By S. W. McGee and C. H. Sump

RECENT advances toward the development of nuclear power for marine propulsion have emphasized the need for materials that can withstand sliding contact in pressurized water at temperatures of 500 F and over. Materials for this application should have: (1) corrosion resistance, (2) no galling or seizing tendency, and (3) low wear. Contributions in this field would be of value in the advance of conventional steam power plant design also. These material requirements have stimulated research programs to explore wear and corrosion in heated water.

A very satisfactory hard wear-resistant surface was developed at the Foundation that concerned a nitriding process for chromium. Nitrided chromium was found to demonstrate the most satisfactory wear resistance of a variety of materials tested for service in 500 F oxygenated water. Its corrosion resistance was on the order of chromium itself. Apart from this, it is believed that chromium nitriding would be commercially feasible.

The laboratory development of nitrided chromium wear surfaces has resulted in a large part from application of the theories of wear and friction as enumerated by Holm (**1**)[1] and by Bowden and Tabor (**2**). Theoretical considerations led to the modification of metallic chromium to avoid the undesirable features of metal-to-metal contact. The scope of the investigation of wear and friction in high-temperature water has been described recently by Glatter and Westphal (**3**). The development of nitrided chromium at the Foundation was a part of the more general investigation of Glatter and Westphal. It is felt that nitrided chromium merits additional discussion because of its potential usefulness in high-temperature water applications. Of the materials tested by Glatter and Westphal, nitrided chromium has shown unique performance. To the extent of the present test data, this material excelled in low wear and the corrosion resistance.

Effects of the Heated Water Environment

In considering materials for sliding contacts in high-temperature water, corrosion is of paramount concern. Once corrosion resistance is established, the problems of wear, seizing, and galling may be approached. Several investigators have amassed considerable data for heated water corrosion (**4**). However, it appears that at present, corrosion resistance can be definitely established only by tests simulating the environment in question, or by actual service in view of the many variables involved (**5**). In heated-water wear applications, passivating films which would ordinarily give protection to certain materials are continuously being removed mechanically. In addition, the possible hydrolysis of surface oxide films may lead to unexpected attack, and differing electrochemical potentials may stimulate contact corrosion.

It is generally observed, however, that the corrosion products of metals in heated water are oxygen compounds. For example, the wear residue from electrodeposited chromium plate tested in 500 F water gave an X-ray diffraction pattern indicating the presence of both oxidized and elemental chromium. This would indicate that at least part of the heated-water wear mechanism of electrodeposited chromium consists of the continuous removal of oxidation products. In addition, an interesting comparison of heated-water corrosion was obtained for the fourth period elements, titanium, vanadium, and chromium. Each of these metals has a rather high affinity for oxygen. However, the static corrosion resistance of titanium and chromium appear to be adequate, while vanadium is attacked rapidly under static conditions in 500 F water. This is believed to result from the solubility of vanadium oxide surface films that form under these conditions.

After materials having sufficient corrosion resistance are known, the problems of wear, seizing, and galling in heated water are more easily approached. Two lines of thought were followed in attacking these parts of the problem, both based on the avoidance of the catastrophic effects resulting from direct metal-to-metal contact. One approach is to provide a thin lubricating film having low shear strength and corrosion resistance (such as Teflon[2]) at the wear interface. This was accomplished by impregnating

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CORD H. SUMP, supervisor, powder metallurgy research, Armour Research Foundation, has, apart from a consistent emphasis on powder metallurgy spent many years in study of wear, bearings, friction materials, rod mills, grinding wheels, etc.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] E. I. DuPont de Nemours.

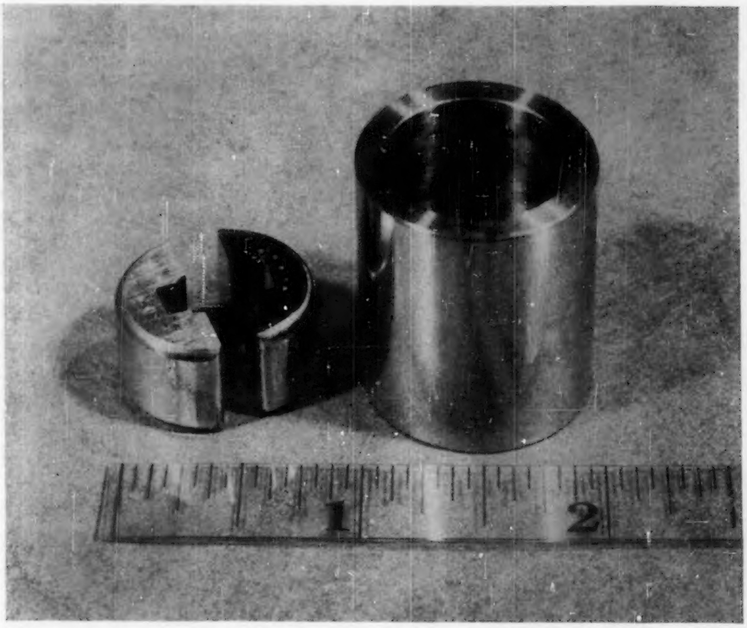

Fig. 1.—Typical Piston Cylinder Test Specimens (× 1.5).

stainless steel with a Teflon dispersion. The other method tried in this development, using nitrided chromium, was intended to avoid true metal-to-metal contact by surface modification of one or both of the mating wear surfaces.

Wear Test Performance in High-Temperature Water

The simulated wear test or "piston-cylinder" test adapted by Glatter and Westphal makes use of two specimen components. These consist of a split piston and a hollow cylinder. Typical piston-cylinder test specimens are illustrated in Fig. 1. The two halves of the split piston are forced against the inner cylinder walls by means of a calibrated spring separating them. During a test, the assembly is contained inside a water-filled autoclave at the required pressure, temperature, and oxygen content. The split piston is driven in reciprocating motion from outside the autoclave by means of a shaft passing through a series of seals and alignment bearings.

A few of the representative wear rates, as determined by Glatter and Westphal, are listed in Table I. The selection is listed here merely to illustrate the difference of magnitude observed for various material combinations. Conditions of high, low, and intermediate wear are illustrated.

TABLE I.—SELECTED RESULTS OF PISTON-CYLINDER WEAR TESTS (*3*).

All tests performed at 500 F in oxygenated water; radial load, 3 lb; first item is piston.

Material Combinations	Weight Loss, mg per lb load per million cycles
Nitrided chromium plate-nitrided chromium	0.0
As-plated chromium-nitrided titanium	4.7
Honed chromium plate-Stellite No. 3	8.3
Honed chromium plate-Kentanium K-151	16.0
As-plated chromium-as-plated chromium	32.0
Stellite No. 3-Stellite No. 3	65.0
U. S. Steel Type W-Stellite No. 3	130.0
Stellite No. 3-Hastelloy D	300.0
Stellite No. 3-Armco 17-4 (SA)	700.0
Type 304-Type 304	3200.0

Material Selection

Several important mechanisms in metallic sliding friction have been considered in the test program. It is known that Bowden and Tabor have demonstrated that in many instances of metallic friction, small metallic junctions are formed across the friction interface. As the engaging surfaces continue to move, old junctions are ruptured and new ones formed. The formation of junctions is related to the existence of asperities and some degree of microscopic roughness on even the most highly polished surfaces. During rubbing, high unit loading exists in the region of asperities, elevated temperatures may be reached and microscopic welds may form. For the application considered, this leads to the conclusion that low wear and nongalling are associated with hard, friable, and nonweldable surfaces that will have in addition to corrosion resistance:

1. Little or no tendency to form welded junctions at asperities.
2. Resistance to plowing and scoring by wear particles.
3. The ability to allow the shearing of any junctions that might be formed without yielding and plastic flow which would result in galling.

Both nitrided chromium and nitrided titanium were considered as test materials. Both appeared to offer high corrosion resistance in heated water, and the requirements for wear and nongalling performance was indicated, also. According to Schwarzkopf (**6**), the transition metals of the fourth, fifth, and sixth groups of the periodic table form nitrides that have metallic character and are distinguished by high hardness and thermal stability. It was found in testing, however, that the depth of hardness penetration obtainable in nitrided titanium is presently insufficient to give consistent results. Some nitrided titanium specimens gave excellent wear performance, while in others the shallow nitrided layer was disrupted and galling resulted. This was true particularly when the specimens were lapped to develop surface smoothness. Figure 2 illustrates a galled nitrided titanium test cylinder. The depth of hardness penetration obtained in nitrided chromium, on the other hand, was of sufficient magnitude that honing could be performed with no loss in wear performance.

Preparation of Nitrided Chromium

Two compounds of chromium with nitrogen have been listed by Schwarzkopf: CrN, having the cubic NaCl type lattice, and Cr_2N, presumed to be arbitrary interstitial nitrogen in the chromium lattice. Either structure would be expected to exhibit nondeforming characteristics. Hence, when structures of this type experience wear, they would be expected to form fine friable wear particles. It was thought that these characteristics would approximate the idealized wear surface for the application in question. It was imagined that these properties of the nitrides would be approached in the outer chromium surface layers, there being a graduation of properties toward

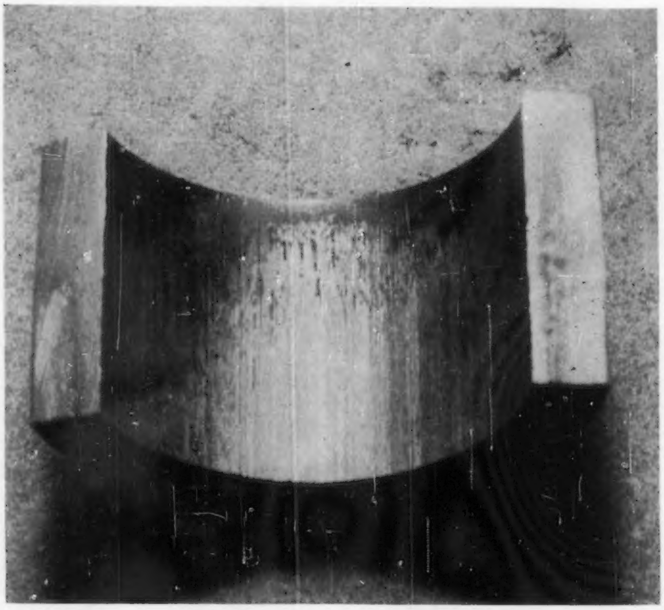

Fig. 2.—Galled Nitrided Titanium Test Cylinder (× 3 diam.).

unmodified chromium at some depth below the surface.

Previous investigations have indicated that nitrogen is absorbed by chromium in the solid state. According to Duparc, Wenger, and Schussele (**7**) an "absorption threshold temperature" of chromium for nitrogen has been observed at 1200 F and another at 1380 F for samples of differing purity.

Several factors led to the selection of anhydrous ammonia as the experimental nitriding medium. It was possible that the presence of nascent N_2 from the reaction $2NH_3 \rightleftarrows N_2 + 3H_2$ at the specimen surface might aid the process. But perhaps more important, a low dewpoint can be obtained with anhydrous ammonia when reasonable precautions, such as leak tightness and the maintenance of positive flow, are observed. The effects of hydrogen on the underlying chromium were not considered to be important at this point.

For initial experimental purposes, arc-melted electrolytic chromium specimens were prepared. Electrolytic chromium granules were outgassed according to the method described by Potter and Lukens (**8**). Arc melting was performed under a partial pressure of argon using a nonconsumable tungsten electrode. The initial outgassing treatment was found necessary to obtain sound arc-melted ingots.

A time-and-temperature cycle to produce adequate case depth using an anhydrous ammonia atmosphere was determined first. Electrolytic chromium specimens $\frac{1}{2}$ by 1 by $\frac{1}{16}$ in. were treated in flowing ammonia at increasing temperatures for 12-hr periods above 1000 F. Maximum file hardness without severe cracking or distortion was obtained at 1650 F under these conditions. To gain adequate depth in the nitrided case, increasing periods of time for the treatment at 1650 F were then explored. In this way, a treatment to produce a hard case depth of approximately 0.006 in. on electrolytic chromium was developed. This treatment consisted of holding specimens for a 96-hr period at 1650 F in flowing anhydrous ammonia. For the purposes of standardization and reproducibility, all nitrided chromium heated-water test specimens were subsequently given this treatment. Figure 3 shows a typical nitrided case structure developed on electrolytic arc-melted chromium by the 96-hr treatment at 1650 F.

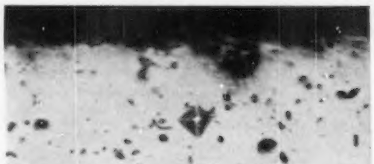

Fig. 3.—Typical Nitrided Arc-Melted Chromium Microstructure (Unetched) (× 500).

In preparing subsequent test specimens, the following conditions were established:

(*a*) Nitriding chamber consisted of a $1\frac{1}{4}$ in. inside diameter smooth bore Vycor tube.
(*b*) Dewpoint of exit gases from nitriding chamber (−40 to −45 C).
(*c*) Dissociation values after 69 to 70 hr of 86 to 96 per cent. (Determined by titration of residual NH_3.)
(*d*) NH_3 flow rate: 16 cc per sec.

The adaptation of nitrided chromium wearing surfaces to modified core structures was investigated. Combinations which offer promise are:

1. Nitrided electrolytic chromium-plated stainless steel, diffusion bonded to the plated surface before nitriding,
2. Nitrided powder metal chromium, and
3. Nitrided pack chromized surfaces.

Initial attempts to nitride electrolytically deposited chromium plate in the as-plated condition gave uncertain results. Although surface hardening was accomplished, an erratic spalling tendency was present. To correct the spalling tendency, a diffusion bonding treatment was undertaken. Treatments in dry hydrogen and under vacuum at 2000 F proved to be inadequate to bond chromium plate strongly enough to correct spalling. However, a 4-hr treatment at 2400 F under dry hydrogen did prove adequate. Several types of austenitic stainless steels including the precipitation hardening grades have been chromium-plated, diffusion-bonded, and subsequently nitrided without spalling.

One of a series of bend test speci-


Fig. 4.—Although cracking occurs on bending of nitrided chromium plate, the hard layer is still adherent (× 5).

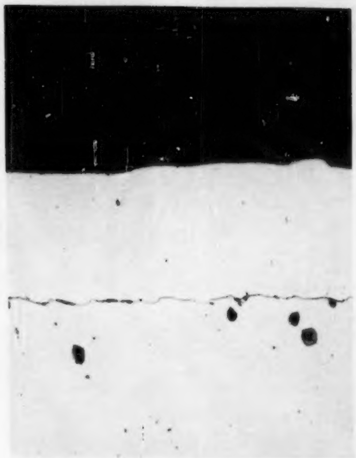
Fig. 5.—Five-mil Chromium Plate on Type 302 Stainless Steel (Etchant: Acid Ferric Chloride) (× 100).


Fig. 6.—Five-mil Chromium Plate on Type 302 Stainless Steel As-Plated and Diffusion Bonded (Etchant: Acid Ferric Chloride) (× 100 diam.).

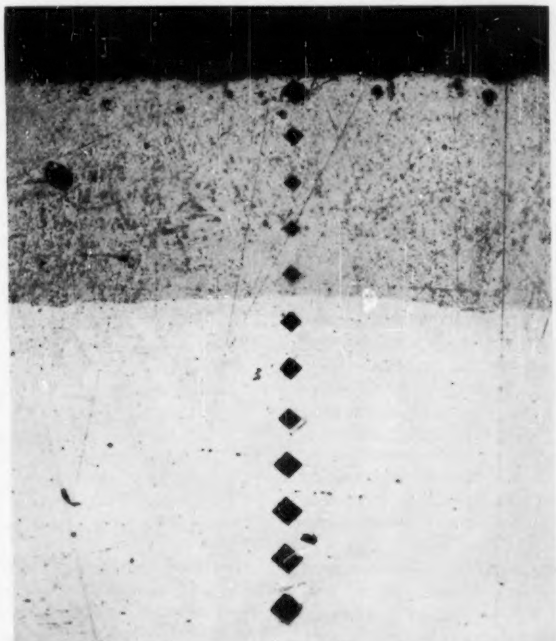
Fig. 7.—Diffusion Bonded Chromium Plate After Nitriding (Unetched) (× 150).

mens, prepared in order to judge the degree of adherence of nitrided chromium plate is shown in Fig. 4. The most satisfactory results were obtained with plate thicknesses of 0.003 to 0.005 in.

Progressive changes in microstructure, as they accompany the diffusion-bonding and nitriding treatment, are illustrated in Figs. 5, 6, and 7. It is of interest to note in Fig. 7, that the advancing region of hardness penetration follows closely the original high-chromium region and appears to encounter a barrier in the vicinity of the old chromium-stainless steel interface. It would be expected that the mobility of interstitial nitrogen atoms would be lessened in the more complex interface region where chromium, iron, nickel, and other elements in minor amounts all are present.

Major effort had been placed upon the preparation of nitrided arc-melted chromium and diffusion-bonded nitrided chromium plate for testing in 500 F water. The ammonia nitriding process was applied also to chromium specimens prepared by powder metallurgy techniques and to pack chromized austenitic stainless steel specimens.

Porous chromium was prepared by compacting annealed −60 + 100 mesh powder at 35 tons per square inch and sintering the briquets for 1 hr at 2400 F in hydrogen. The average density of the sintered compacts was 70 per cent.

The chromium compacts were nitrided in anhydrous ammonia using the same procedure as for arc-melted chromium (96 hr at 1650 F in anhydrous ammonia flowing at 16 cu cm per sec). The microstructure of the nitrided powder metal chromium appeared to consist of two phases. The phase having rounded contours and being most abundant toward the specimen surface was presumably high in nitro-

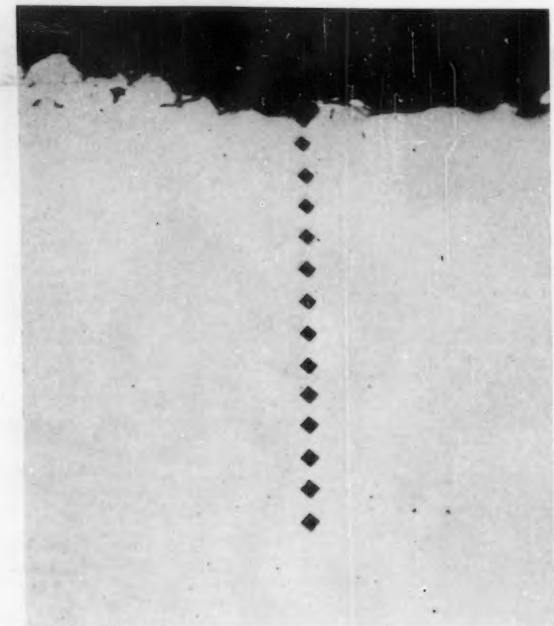

Fig. 8.—As-Pack-Chromized Type 302 Stainless Steel (Unetched) (× 100).

Fig. 9.—Nitrided Chromized Type 304 Stainless Steel (Etchant: Carapella's Reagent) (× 100).

gen. Microhardness readings have proved erratic and unreliable because of body porosity. However, the 96-hr nitriding treatment developed file hardness to a depth of 0.250 in. beneath the surface. This depth of case is in excess of what would be required for most practical purposes. A useful nitrided case, having wear and corrosion resistance, could undoubtedly be developed in porous powder metal chromium through a relatively brief elevated temperature treatment in ammonia.

For pack chromizing, type 304 stainless steel was packed in chromizing compound and held for $5\frac{1}{4}$ hr at 2400 F in dry hydrogen. The chromizing compound consisted of 100-mesh electrolytic chromium containing 10 weight per cent 300 mesh alumina to prevent agglomeration during the treatment. Figure 8 illustrates the as-chromized structure of type 304 stainless steel after this treatment; the depth of chromium diffusion of about 0.020 in. is indicated by the diamond pyramid penetrator survey.

After nitriding with ammonia for 96 hr at 1650 F, a deep case was developed on the chromized stainless steel (Fig. 9).

It is assumed that the nitriding time could be shortened to permit the use of thinner cases. The general case hardness averaged 750 Vickers Hardness Number (100-g load) as compared with the original body hardness of 250 Vickers Hardness Number (100-g load). On a basis of hardness alone, the chromized material was inferior to the chromium plate after nitriding.

Conclusions

An attempt has been made to apply several fundamental interpretations of wear phenomena in the search for materials able to withstand prolonged sliding contact in heated oxygenated water. As a result of these efforts, it may be proposed that one class of materials to fulfill this requirement has the following surface characteristics:

1. Inertness in the heated-water environment as opposed to corrosion resistance dependent upon passivating surface films.
2. High hardness and thermal stability.
3. Microfriability during wear as opposed to gross welding and seizure. Junctions at asperities, if formed, would be fragmented readily.

Nitrided chromium wear surfaces represent a means of securing these requirements. Nitriding processes for chromium and chromized surfaces have been carried forward through several stages of development. The ammonia nitriding process for chromium and chromized surfaces is felt to offer great promise toward providing improved materials for heated-water service or any similar condition where inadequate lubrication exists.

Acknowledgment:

The authors wish to express their appreciation to the Atomic Energy Commission who sponsored this work through the Westinghouse Atomic Power Division under Subcontract 14-309 Task IV. Messrs. J. Glatter, A. Squire, and R. Westphal conducted the wear tests at Westinghouse Atomic Power Division.

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A Rapid Fatigue Test for Rolling Contact Materials

By Earle A. Ryder and Gilbert C. Barnes

To cope with the heavy loads and high speeds in jet engine bearings, better knowledge is needed of the fatigue strength and life of available materials. This information will not be gained from tests of complete engines and must be secured from bench tests of various kinds. The authors describe a small-scale comparative test for materials.

THE combination of high speed, high load, and temperatures of 600 F or higher take the jet engine thrust bearing beyond the field where we have adequate data for design purposes. Ball bearing life has always been characterized by excessive scatter (50 to 1 or more), but for aircraft use it is not the scatter but the *minimum life* that counts. Effort must, therefore, be concentrated on raising this minimum, and improvement in materials offers far more chance of gain than do other factors such as design.

In usage the bearing manufacturers consider the mean life, or the load giving 10 per cent of failures, to the extent of neglecting work on raising the minimum life, or what is the same thing, eliminating the poorest bearings before they are shipped to customers. Some test results that have been published indicate that large gains are possible through better control of the materials for balls and races.[1] However, to cope with the heavy loads and high speeds in jet engine bearings, a great deal more information is needed on such subjects as the following:

1. Fatigue properties of alternate materials. (The conventional 52100 steel is being partly replaced by high-speed tool steels such as M-1, M-2, M-50, etc.)
2. Fatigue properties at elevated temperature, particularly in the 400 to 600 F range.
3. Relation of elastic limit to endurance, for rolling contact.
4. Effect of trace elements or residuals. (Preliminary tests have shown a big improvement in life concurrent with holding residual elements to low concentrations.)
5. Vacuum melting. (This has produced both good and poor results.)
6. Effect of lubricant viscosity. (Tangible data are needed.)
7. Effect of lubricant composition. (Stress corrosion may be a factor.)
8. Correlation of rotating-beam and rolling-fatigue tests.

Test Methods

It can be argued that only the engine gives the final answer on materials, but it is impossible to do any systematic fatigue testing of materials in engines because not enough such tests can be run. Similarly, the testing of complete bearings is not a good answer because it consumes a great deal of time and introduces a lot of factors besides the materials used. For the direct comparison of materials and lubricants, small-scale bench tests should be used. There are a number of such tests available.

Roller machines of the Amsler or Buckingham type have been used, but the authors are not aware of any data from these machines that will apply to the present problem. A three-ball machine has been built in which the balls are positioned in a cage between two oppositely rotating disks. This rig eliminates the centrifugal force of the balls. Another rig using a single ball has been developed by Macks at National Advisory Committee for Aeronautics in which an air jet is used to drive a ball at high speed inside a cylindrical steel cup. The motion of the ball causes centrifugal force which is the loading force. Several of these machines are in operation.

Another and simpler single ball test rig developed by G. C. Barnes of Pratt & Whitney Aircraft is shown schematically in Fig. 1. The Barnes machine uses a single ball as a specimen and the ball is positioned by a bronze cage between two rotating drums. The drums are pressed toward each other with a controlled amount of force. While one drum is rotated, the other drum coasts. The test ball has two flats ground on its poles to steer it so that all load occurs on one equator. When the machine is operated properly, a ball failure always results instead of a drum failure. About 8,000,000 stress cycles per hour are imposed on the ball.

In addition to the rapid accumulation of cycles, the test ball is easily changed. When a fresh ball is installed, the cage is moved axially so as to present a new track on the large rollers. In this way about nine tests are run per pair of

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

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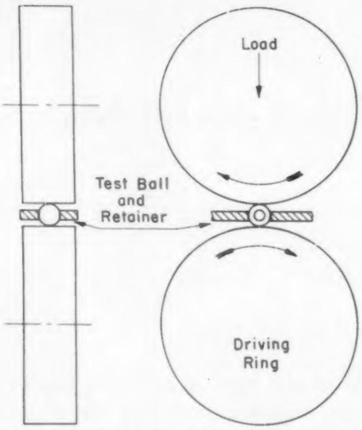

Fig. 1.—Ball Fatigue Machine Schematic.

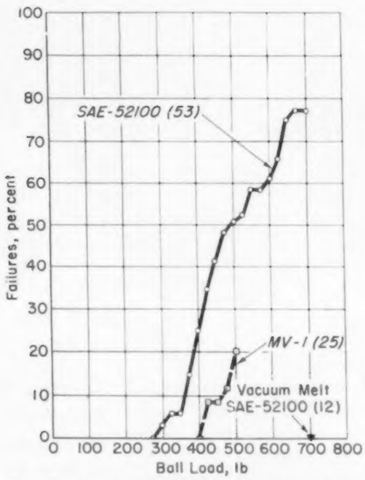

Fig. 2.—Typical Test Results from Three Kinds of Material. Eight of the 53 balls and 19 of the 25 balls ran to the limits shown without failure.

rollers using a fresh track each time. The load on the ball can be raised to high values for making short-time tests if desired.

Oil can be supplied to the test ball by squirts in any desired manner. By using heated oil and circulating enough of it, the working parts of the machine can be raised to a temperature of 250 or 300 F. For higher temperatures it might be desirable to build a modification of the machine with overhung drums so that the test ball and drums could be remote from the slave bearings. This would allow heating the ball to considerably higher temperature than the bearings.[2]

Typical Results

Some test results from the Barnes' machine are shown in Fig. 2. Each curve relates to a single lot of balls of one kind; for instance, the curve at the left represents 53 balls of SAE 52100 steel. The abscissa shows the load on the ball and the ordinate shows the percentage of the total lot which had failed at each load. These tests were made by starting at 250 lb and adding 25 lb loads every four million cycles, that is to say, every half hour. In each case, some balls had not failed by the time the maximum load of 700 lb was reached. The shape of the curves, indicating no failures at positive loads, is strong evidence for the existence of a fatigue limit in the material contrary to the generally held view of those who test quantities of complete bearings.

Results of tests of 12 balls of SAE-52100 vacuum melt steel show no failures at 700 lb (Fig. 2). It is felt that this illustrates the great possibilities in metallurgical improvements. It is well known that many vacuum heats have been produced which showed poor results both in specimen form and in shape of complete bearings. The solution of the vacuum melting problem has as yet not been found.

It is desirable that information on the subjects listed previously be obtained as soon as possible and without attempts to split hairs. For this purpose, a simplified test of the kind described should be most useful as progressive loading of the specimens has considerable advantage. It is possible to correct data obtained in progressive loading tests to make them comparable to those obtained by conventional methods of fatigue testing. However, when one is looking for general answers and merely trying to detect big differences, this is hardly necessary.

It is hoped that someone will soon set up a battery of test machines of the simplest kind to obtain comparative results on the metals and lubricants from which a selection has to be made.

[2] Detailed drawing showing the layout of the Ball Fatigue Machine may be secured from the author.

Radioactive Tracers in Nondestructive Inspection of Internal Components

By Sigmund Berk, Helen Ebert, and Harlow M. Keeser

THE presence of a critical part, the shear pin, in cartridge actuated devices (CAD) cannot be detected by presently used nondestructive 220 kvp fluoroscopic inspection methods because of the dense materials surrounding the pin. The M5 and M3 cartridge actuated devices contain a cadmium plated, copper shear pin, 1 in. in length and $\frac{3}{64}$ in. in diameter, housed in the steel head. A similar type but smaller pin, approximately $\frac{3}{8}$ in. in length and $\frac{1}{32}$ in. in diameter, is present in the M1 thruster (Fig. 1).

A number of preliminary studies indicated that radiation from radioactive materials can be used as a marker for determining the presence or absence of a part, or the position ("safe" or "firing") of a contact switch in an assembled item, such as the arming mechanism of an electronic fuze. This application of radioisotopes may be termed "physical tracing" since the radiation emitted from the radioactive "tag" is used only to indicate the location of the marked item (**3**).[1]

Whitehouse and Putman (**5**) summarized the uses of radioisotopes as markers for the following purposes: the location of missiles after test firing, the following of moving parts of enclosed machinery, and for level indicators in sealed tanks. Tomes and Brian (**4**) followed the movements of beetles below the ground with 5 μg of radium sulfate attached to their bodies. Arnason *et al* (**1**) used cobalt-60 in the body of wireworms to trace their movements in the soil and also to record the depth of penetration in the ground by the observed attenuation of the gamma radiation.

The choice of the radioisotope for labeling or marking the critical part depends on (*a*) the type and thickness of metal which the radiation from the labeled part must penetrate and (*b*) the length of time after assembly before the nondestructive inspection tests will be made. A number of radioiso-

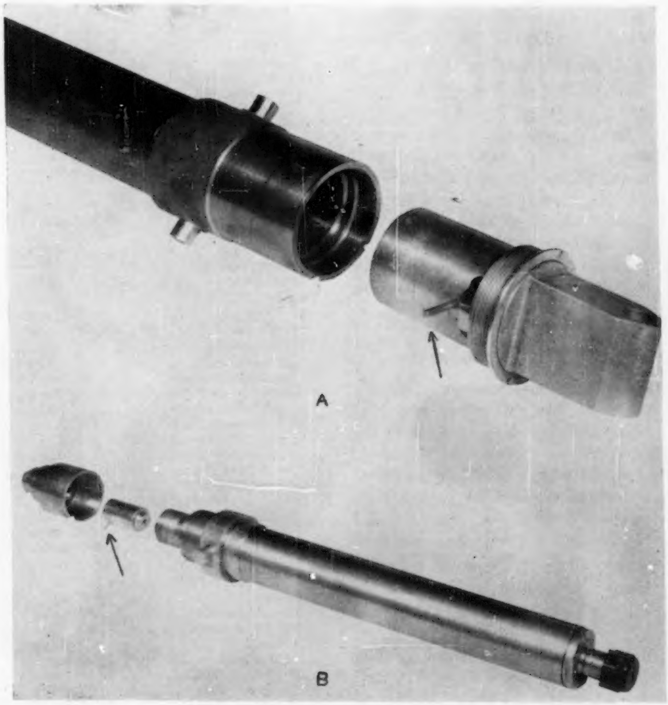

Fig. 1.—Shear Pins and Steel Casings Through Which Radiation Must Pass.
A—M5 Catapult; B—M1 Thruster.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

topes (Table I) is available with different energies to satisfy the first requirement and with varying half-lives to satisfy the second requirement.

Of the gamma emitters (Table I) readily available, silver-110 was chosen as the radioisotope best suited for tagging the shear pins. This isotope has the following advantages: (*a*) Formation of a uniform and adherent coating on the copper pin by simple chemical displacement, (*b*) plating to completion at the concentrations recommended so that there is no problem of disposing of the spent radioactive plating solution, (*c*) no interference with the electrodeposition of cadmium, (*d*) formation of cadmium-110 on decay (*e*) emission of gamma radiation of sufficient intensity to permit thicknesses of the steel head up to 1 in. or more and (*f*) a half-life (270 days) such that the pins can be prepared several months in advance, yet the activity used will be reduced to the background of the measuring instrument in from 2 to 3 yr.

TABLE I.—CHARACTERISTICS OF GAMMA EMITTING RADIOISOTOPES AS MARKERS IN NONDESTRUCTIVE TESTING.

Radioisotope	Half-life	Energy of Radiation, Mev					Cost per mc
		Beta		Gamma		Other	
		Min	Max	Min	Max		
Antimony-124	60.0 days	0.5	2.37	0.12	2.3	...	$ 3.00
Arsenic-76	26.8 hr	0.4	3.1	0.6	2.1	...	0.48
Barium-131[a]	12.0 days	...	...	0.26	1.2	K[b]	5.50
Cesium-131	9.6 days	...	...	...	...	K[b]	...
Barium-137[a]	2.6 min	...	...	0.66	...	I.T.[c]	...
Cesium-137	37 yr	0.5	1.2	...	...	...	0.50
Barium-140[a]	12.8 days	0.48	1.02	0.16	0.54	...	0.50
Lanthanum-140	40.0 hr	1.32	2.26	0.09	2.9	...	...
Beryllium-7	54.5 days	...	...	0.48	...	K[b]	75.00
Bromine-82	35.5 hr	0.47	...	0.55	1.31	...	0.16
Cadmium-115[d]	2.3 days	0.46	1.1	0.34	0.52	...	12.00
Cadmium-115[d]	43.0 days	1.67	...	0.5	...	...	33.00
Cerium-141	28.0 days	0.41	0.56	0.14	0.32	...	1.00
Cerium-144[a]	275 days	0.17	0.3	...	0.13	...	...
Praseodymium-144	16.5 min.	0.8	3.0	0.7	2.2	...	0.50
Cesium-134	2.3 yr	...	0.66	0.57	0.79	...	1.00
Chromium-51	26.5 days	...	...	0.32	...	K[b]	1.00
Cobalt-60	5.3 yr	0.31	...	1.17	1.33	...	2.00
Copper-64	12.9 hr	0.57	...	...	...	K[b]	0.12
		0.65[e]	...	1.34	...	...	...
Europium-152[f]	5.3 yr	0.9	1.7	0.3	1.2	K[b]	...
Europium-154	5.4 yr	0.3	1.9	...	1.2	...	2.00
Gallium-72	14.3 hr	0.56	3.17	0.6	2.5	...	0.50
Gold-198	2.7 days	0.97	...	0.41	...	...	0.25
Hafnium-181	46.0 days	0.41	...	0.09	0.48	...	1.35
Indium-114	50.0 days	2.05	...	0.19	0.72	K[c], I.T.[c]	5.00
		0.65[e]	...	1.27	...	...	...
Iodine-131	8 days	0.15	0.81	0.08	0.7	...	0.75
Iridium-192	70 days	...	0.67	0.14	0.65	...	1.00
Iridium-194	19 hr	0.48	2.18	0.38	1.43	...	0.20
Iron-59	46.3 days	0.26	0.46	1.1	1.3	...	35.00
Lanthanum-140	40 hr	1.32	2.26	0.09	2.9	...	0.30
Mercury-203	43.5 days	0.21	...	0.29	...	...	0.20
Molybdenum-99	2.9 days	0.5	1.22	0.14	0.36	...	0.30
Neodymium-147[f]	11.0 days	0.17	0.78	0.04	0.58	...	12.00
Promethium-147	2.7 yr	0.22	...	...	...	...	...
Niobium-95	35.0 days	0.15	...	0.76	...	...	5.00
Osmium-191	15.0 days	0.14	...	0.04	0.13	...	1.00
Potassium-42	12.4 hr	2.04	3.58	...	1.51	...	0.10
Praseodymium-142	18.9 hr	0.66	2.23	0.13	1.6	...	0.40
Radium-226	1590 yr	0.65	1.17	0.01	1.80	...	...
Rhenium-186	3.87 days	0.64	1.09	0.13	1.7	...	0.20
Rubidium-86	19.5 days	0.72	1.82	1.1	...	...	0.20
Ruthenium-103	42.0 days	0.22	0.68	0.49	...	...	2.00
Ruthenium-106[a]	1.0 yr	...	0.04	...	...	...	...
Rhodium-106	30 sec	2.3	3.55	0.5	1.25	...	5.00
Scandium-46	85 days	0.36	1.49	0.89	1.12	...	3.00
Selenium-75	127 days	...	...	0.07	0.41	K[b]	1.00
Silver-110	270 days	0.09	2.86	0.68	1.52	...	1.00
Sodium-24	14.9 hr	1.39	...	1.38	2.76	...	2.00
Tantalum-182	117 days	0.5	1.1	0.05	1.24	...	2.00
Tungsten-185	73 days	...	0.43	...	0.13	...	4.00
Tungsten-187	24.1 hr	0.63	1.32	0.07	0.68	...	0.40
Zinc-65	250 days	...	0.32[e]	...	1.11	K[b]	2.00
Zirconium-95[a]	65 days	0.4	0.89	...	0.71	...	1.00
Niobium-95	35 days	...	0.15	...	0.76	...	...

[a] In radioactive equilibrium.
[b] K = K capture.
[c] I.T. = isomeric transition.
[d] Sold as a mixture of short and long lived isomers.
[e] Positrons.
[f] Sold as a mixture.

Preparation of Plating Solution

Processed silver-110 of high specific activity was obtained from the Oak Ridge National Laboratory. Since the radioactive silver is provided dissolved in nitric acid it is only necessary to dilute it in order to prepare an appropriate stock solution. However, it was found desirable to add 10^{-3} moles per liter of sodium cyanide to the stock solution to prevent significant adsorption of silver ions on the glass and polyethylene vessels.

A plating solution containing 0.01 μc (microcurie) per ml of silver-110 and 10^{-3} moles per liter of sodium cyanide was used. This solution has a silver concentration of 5×10^{-8} to 10^{-6} moles per liter. One milliliter of the stock solution is used for each pin to provide an activity of 0.01 μc per pin, and 2 ml are used for the higher activity of 0.02 μc per pin. The pins are plated for 45 min by simple chemical displacement in the radioactive solution contained in one-pint polyethylene bottles.

Cleaning and Plating Procedure

A uniform and adherent deposit of silver depends significantly upon the preparation of the copper pins for plating. The following procedure was found satisfactory:

(*a*) rinse the pins in acetone and dry,
(*b*) place pins in boiling alkaline cleaner for 10 min.,
(*c*) rinse with tap water,
(*d*) place pins for 10 min in boiling 0.1 *N* NaCN containing a trace of NaOH,
(*e*) immediately place the pins in the plating solution contained in 16 oz (1-pint) polyethylene bottles measuring approximately 3 in. across the base,
(*f*) agitate the pins in the solution on a rotary-type shaker at 160 rpm during the 45 min plating by simple chemical displacement,
(*g*) decant the spent solution,
(*h*) rinse the pins in the bottle four times by adding tap water for each rinse, and
(*i*) drain the pins and let them air dry or hasten drying by using an infrared lamp.

Cadmium Plating and Sealing Procedure

The nonradioactive shear pins which are currently used have a chromate-sealed, cadmium plate over the copper. The cadmium coating is applied to reduce the possibility of electrochemical corrosion between the copper pins and steel housing. Since the plating of silver on the copper pin does not remove the possibility of corrosion, it was decided to put a cadmium coating over the radiosilver labeled pins. The cadmium plate serves the additional purpose of covering the radioactive surface to prevent rub-off of radioactive silver during handling.

The radioactive pins need no additional preparation for cadmium plating. The cadmium can be electroplated (current density of 20 amp per sq ft) over the extremely small amount of silver to form, in less than 10 min, a bright coating (approximately 0.0002 in. thick) that will withstand a 15-sec chromic acid supplementary dip which is required to passivate the surface.

Measurement of Radioactivity of Silver-110 Labeled Pins

Ten pins each for the catapult and for the thruster were prepared according to the procedure described. Five of each were labeled with 0.01 μc of radiosilver per pin and five with 0.02 μc per pin. The radioactivity of the pins was determined individually after application of the silver-110 and the cadmium coating, respectively, in order to determine the variation in radioactivity occurring among the labeled pins. For this purpose a Geiger-Mueller (G-M) counter was used with no absorber between the pin and the mica window. The results are shown in Table II. It can be seen that the activity among pins is satisfactorily constant. In some instances, the application of the cadmium coating decreased the measurable radioactivity up to 33 per cent.

Wipe Tests

Wipe tests (2) were made after both the radiosilver and the cadmium plating in order to indicate the ease of removal of radioactivity to be expected during handling. In making these tests a square piece of filter paper (Whatman No. 3), almost the length of a shear pin, was moistened with distilled water and held around the pin with finger pressure. One end of the pin extended outside the paper far enough to be grasped by tweezers and rotated five times. The squares of filter paper were straightened, placed on aluminum planchets, and counted with a G-M counter (Table III).

The catapult pins plated with 0.01 μc silver-110 per pin and not protected with a cadmium coating gave wipe tests of 1 to 7 counts per min above background (20 counts per min), while wipe tests from pins plated with 0.02 μc silver-110 had 8 to 14 counts per min above background. However, the thruster pins gave higher values in the tests, that is, 6 to 12 counts per min for the 0.01 μc group and 17 to 36 counts per min for the 0.02 μc group. It appears that the more active coating of radioactive silver on the smaller thruster pins is not as adherent as on the larger catapult pins. It is possible that a thicker and less adherent coating is formed on the smaller pins.

TABLE II.—RADIOACTIVITY OF SHEAR PINS LABELED WITH SILVER-110.

Pin	Activity before Cadmium Plating, counts per min		Activity after Cadmium[a] Plating, counts per min	
	Catapult	Thruster	Catapult	Thruster
0.01 μc per pin[b]				
No. 1	1290	1253	1060	904
No. 2	1310	1196	1059	805
No. 3	1289	1142	1026	889
No. 4	1324	1137	1090	829
No. 5	1296	...	1064	...
Average	1302	1182	1060	857
Standard deviation	13	33	20	41
0.02 μc per pin[b]				
No. 1	2617	2206	1977	1528
No. 2	2621	2120	1979	1421
No. 3	2522	2085	2034	1415
No. 4	2618	2139	2083	1407
No. 5	2605	2126	1915	1389
Average	2593	2135	1996	1432
Standard deviation	38	40	60	49

[a] All values shown are averages of 2 or more 10,000 counts per pin.
[b] Maximum value obtained by plating to completion.

TABLE III.—RESULTS OF WIPE TESTS FROM SHEAR PINS LABELED WITH SILVER-110.

Pin	Without Cadmium Coating, counts per min[a]		Cadmium-Plated and Chromate-Sealed, counts per min[a]	
	Catapult	Thruster	Catapult	Thruster
0.01 μc per pin				
No. 1	4[b]	10	0	0
No. 2	1	7	0	0
No. 3	7	17	0	0
No. 4	8	6	0	0
No. 5	7	12	0	0
Average	5	10	0	0
Standard deviation	3	4	0	0
0.02 μc per pin				
No. 1	14	21	0	2
No. 2	10	17	0	0
No. 3	10	22	0	0
No. 4	11	20	0	0
No. 5	8	36	0	0
Average	11	23	0	0.4
Standard deviation	2	7	0	0.9

[a] Activities listed in this table are in counts per min above background. The background for the instrumentation used was 20 counts per min.
[b] Values based on total counts of 1000.

The application of a chromate-sealed, cadmium deposit over the silver resulted in no rub-off except in one instance (Table III). The wipe test measurements of the cadmium-plated radioactive shear pins were made within a week after the cadmium plating. Since there is a possibility of some rub-off of radioactivity, it is suggested that rubber gloves or finger protectors be used in handling the radioactive shear pins.

Detection of Shear Pins in Assembled Cartridge Actuated Devices and Thruster

The large and small shear pins labeled with radiosilver and cadmium-coated were placed in the catapult and the thruster, respectively, for measurement of radioactivity with three radiation detection instruments. For nondestructive inspection purposes, it is not essential to make an accurate count of the radioactivity emitted from the assembled item; it is only necessary that the instrument show a significant deflection indicating the presence of radioactivity beyond normal background.

Two scintillation counters connected to rate meters and a G-M survey instrument were evaluated as radiation detection methods for the radioactive pins in the assembled items. The first setup listed in Tables IV and V consisted of a scintillation detector with an RCA No. 5819 photomultiplier tube and a shielded 1-in. thallium-activated NaI crystal. The scintillation detector had a variable gain amplifier which was set to give optimum operating characteristics for the radiosilver radiation. The

counter was connected to a plug-in rate meter, receiving pulses from a scaler. The counter was operated at 1200 v and the time constant of the rate meter was 2.5 sec.

The second radiation detection instrument used was a scintillation counter with an RCA No. 6199 photomultiplier tube and a shielded 1-in. thallium-activated NaI crystal. The counter was connected to an electronic count rate meter (Fig. 2) and operated at 1100 v.

The third radiation detection instrument used was a portable beta-gamma count rate meter. A G-M counter having a glass window thickness of 35 mg per sq cm and operating at 850 v was used as the sensing element with this beta-gamma survey instrument.

Measurements of the amount of radioactivity emitted were taken at the surface and at a distance of 1 in. from the assembled CAD unit.

The results (Tables IV and V) show that the first scintillation counter-rate meter was slightly more sensitive to the detection of the gamma radiation from the silver-110 than the other two instruments. With this counter-rate meter, a reading in counts per min of 18 times background was obtained with the 0.02 μc pins and 9 times background with the 0.01 μc pins. The other two counting systems were less efficient and gave smaller ratios of radiation emitted by pins *versus* background. The three counting systems were chosen because of their availability in Frankford Arsenal. It is believed, however, that more sensitive instrumentation is available or could be developed which would give a still higher differential between radiation emitted from shear pins and background radioactivity. The most desirable instrumentation would give a fast response to radiation and show a maximum deflection in the scale reading of the rate meter. If no pin (therefore, no radioactivity) is present in the succeeding cartridge actuated device, the radiation detection instrumentation used should indicate a rapid return to background.

A number of types of instrument with varied sensing elements is available for the measurement of nuclear radiations. Two types of sensing elements, the G-M counter and the scintillation counter, were used for the measurement of the radiation emitted from the catapults with radioactive shear pins. The advantages in the use of scintillation counters are their extreme speed of operation (400 times as great as G-M counters) and their high efficiency in the detection of gamma radiation (50 times as sensitive as G-M counters). The disadvantages of scintillation counters are their usual high background and high initial cost. Although the G-M counter may have many disadvantages, one being its high insensitivity to gamma radiation, its low initial cost, and the simple recording circuit it requires make it the most widely used sensing element in radiation counters.

The results shown in Tables IV and V indicate that both the G-M and the scintillation sensing elements in the three counters can be used for the detection of the presence of the shear pins in the CAD units. It is important that the rate meter used should have such a scale range that a maximum deflection of the needle will occur when the CAD unit with the radioactive shear pin is brought in proximity to the sensing element.

On the basis of the known advantages of scintillation counters and the results obtained in this study, it is

TABLE IV.—RADIATION EMITTED FROM SILVER-110 LABELED SHEAR PINS IN ASSEMBLED CARTRIDGE ACTUATED DEVICES AS MEASURED AT 2 POSITIONS WITH 3 COUNTING DEVICES.

Pin	Scintillation Detector + Rate Meter, counts per min				G-M Survey Meter mr per hr	
	Detector No. 1		Detector No. 2		Detector No. 3	
	At Surface	At 1 in.	At Surface	At 1 in.	At Surface	At 1 in.
			0.01 μc per pin[a]			
No. 1	7600	2900	2550	2000	0.08	0.03
No. 2	7600	2950	2750	2000	0.08	0.03
No. 3	7500	3100	2750	2000	0.08	0.03
No. 4	7100	3000	2750	1900	0.08	0.03
No. 5	7700	3200	2750	2050	0.08	0.03
Average	7500	3030	2710	1990	0.08	0.03
Standard deviation	235	120	79	55	0	0
Background	815	920	1375	1400	0.015	0.015
Ratio of average count to background	9:1	3:1	2:1	1.5:1	5:1	2:1
			0.02 μc per pin[a]			
No. 1	15 000	5200	4250	2800	0.12	0.07
No. 2	14 600	5000	4150	2850	0.12	0.07
No. 3	14 600	5200	3800	2700	0.12	0.06
No. 4	14 200	5200	3800	2650	0.12	0.07
No. 5	14 400	5100	4050	2700	0.12	0.07
Average	14 560	5140	4010	2740	0.12	0.068
Standard deviation	300	400	204	82	...	0.004
Background	815	920	1400	1450	0.015	0.015
Ratio of average count to background	18:1	6:1	3:1	2:1	8:1	5:1

[a] Maximum activity obtained by plating to completion.

TABLE V.—RADIATION EMITTED FROM SILVER-110 LABELED THRUSTER SHEAR PINS IN ASSEMBLED CARTRIDGE ACTUATED DEVICES AS MEASURED AT 2 POSITIONS WITH 3 COUNTING DEVICES.

Pin	Scintillation Detector + Rate Meter, counts per min				G-M Survey Meter, mr per hr	
	Detector No. 1		Detector No. 2		Detector No. 3	
	At Surface	At 1 in.	At Surface	At 1 in.	At Surface	At 1 in.
			0.01 μc per pin[a]			
No. 1[b]	6100	2800	2700	2300	0.06	0.04
Background	815	920	1700	1700	0.02	0.02
Ratio of average count to background	7:1	3:1	1.5:1	1.3:1	3:1	2:1
			0.02 μc per pin[b]			
No. 1	15 000	5100	3700	2700	0.13	0.07
No. 2	14 100	4700	3500	2800	0.13	0.07
No. 3	14 800	5200	3300	2400	0.13	0.07
No. 4	14 500	5100	3200	2500	0.12	0.06
No. 5	15 400	5000	3300	2500	0.12	0.07
Average	14 760	5020	3400	2580	0.126	0.068
Standard deviation	490	190	200	160	0.006	0.004
Background	1 000	1100	1700	1700	0.015	0.015
Ratio of average count to background	15:1	5:1	2:1	1.5:1	8:1	5:1

[a] Maximum activity obtained by plating to completion.
[b] Only one thruster shear pin labeled with 0.01 μc silver-110 was counted.

recommended that the following instrumentation and procedure be adopted for the inspection of the CAD units for the presence of the shear pins:

1. The catapult or thruster should be placed a distance of 1 in. from a scintillation counter sensing element (Fig. 2). The rate meter will record close to background when the distance between the catapult containing the radiosilver shear pin and the scintillation counter exceeds 4 in.
2. The scintillation detector should have a variable gain amplifier set to give optimum operating characteristics for the radiosilver radiation.
3. The rate meter should have a time constant of 2.5 or less sec.
4. The radiation detector needle on the scale of the rate meter should show a large deflection in the presence of the CAD unit with the radioactive pins.
5. The scale on the rate meter should be calibrated so as to read absence of shear pin (approximately background radiation) or presence of shear pin (minimum radiation above background which indicates presence of shear pin). If desired, an automatic inspection procedure could be easily designed.

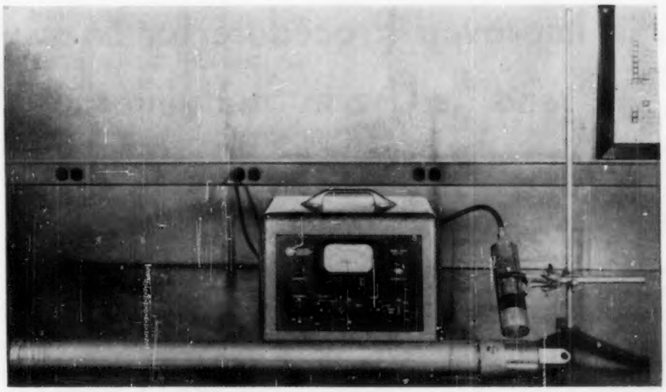

Fig. 2.—Scintillation Counter-Rate Meter (No. 2) Used in the Nondestructive Inspection of Assembled M5 Catapult for Presence of Radiosilver Labeled Shear Pin.

Health Hazards

No radiation health hazards are foreseen in the use of the radioactive shear pins in the nondestructive inspection tests. The amount of radioactivity per pin is so small that marking the unit as to the presence of radioactive silver is not considered necessary. The Surgeon General, Army Environmental Health Laboratory, concurs in this opinion. It is also their opinion that the short half-life of the silver-110 and the plating process, utilizing cadmium to plate over the radioactive silver, are factors which assure minimal exposure under the most extreme conditions of use or storage.

Also, a minimal exposure to radioactivity will be encountered in the shipment and storage of the CAD units. Each CAD unit is placed in a cardboard container and four such packages are placed in a wooden box, 50 by $9\frac{1}{2}$ by $9\frac{1}{2}$ in. The maximum radioactivity at the surface of the wooden box containing the four assembled CAD items is 0.045 mr when measured with a G-M beta-gamma survey instrument. With an ionization type survey instrument, "Cutie Pie," no radioactivity above background was obtained. In storing 600 wooden boxes (the maximum number shipped at one time) containing four assembled CAD units each, no appreciable increase in the measured radioactivity would be obtained above that from one box.

It was recommended that firm controls be established to assure that the radioactive pins do not reach the open market if they should become surplus. The radioactive shear pins after six years would be decayed down to background radiation.

The use of the radioactive shear pins without marking is authorized, provided that instructions accompany the CAD items, describing methods of disposal according to army regulations.

In the preparation of labeled pins, no hazard from radiation should be encountered. It is suggested that the plating solutions be prepared by personnel familiar with the techniques of handling radioisotopes. The plating can be done by trained shop personnel. As described in this report, the radioactivity of the plating solution would not exceed 1 μc per bottle. This quantity would plate fifty 0.02 μc pins or one hundred 0.01 μc pins. Radiation from the container is 1.5 mr per hr at the surface and is considered safe for the short periods of handling, since the total body exposure permitted is 300 mr per week.

After plating has been completed the supernatant liquid can be disposed of in the public sewage if it shows no radioactivity above background. If the radioactivity is above background the effluent can be decontaminated by plating any residual radioactivity on zinc dust.

The plated 0.02 and 0.01 μc pins should be kept in shielded boxes or drawers in lots of 50 or 100 so that the radioactivity at the assembly line will be at a minimum.

The outlined radioactive tracer method for the nondestructive inspection of catapults for critical parts can be used with slight modifications for the inspection of other ordnance items. Further work is contemplated to evaluate other radioisotopes (especially, short lived emitters) as radiation markers for critical ordnance parts in assembled items.

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The views expressed by the authors are their own and do not necessarily represent the views of the Defense Department.

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An Improved Procedure for Measuring Tensile Modulus and Its Use in Studying the Modulus-Density Relationship for Polyethylene Resins*

By C. H. Adams and R. H. Supnik

The standard deviation of the tensile modulus determination has been improved from ±12 per cent to ±6 per cent. Using this improved technique, it is shown that modulus is a linear function of density for commercially available high-pressure polyethylene resins.

A METHOD of improved accuracy and precision has been developed for measuring tensile modulus of polyethylene resins. The standard deviation was decreased from ±12 per cent with the old procedure to ±6 per cent with the new one. With this new method, tensile modulus was shown to increase continually for the first few days after the sample is molded, and modulus was shown to be a linear function of density for commercially available polyethylene resins.

This paper describes the development of the improved method and then discusses the use of this technique to correlate modulus with density and time after molding.

Development of Improved Procedure for Measuring Tensile Modulus

With the method in use when this study was undertaken test results were unreliable and inadequate as shown not only by poor reproducibility within samples and between operators but also by lack of correlation with crystallinity. Richards had reported that modulus was a direct function of crystallinity (1),[1] and since density is a measure of crystallinity, at least to a first approximation modulus should also be a direct function of density.

The modulus test procedure was, therefore, analyzed in detail. According to ASTM Method D 882[2] tensile modulus is determined by drawing the tangent to the initial portion of the load-elongation curve obtained with a constant rate of jaw separation. The Instron tension testing machine was used with a crosshead rate of 5 in. per min and a chart magnification of 4 to 1. A typical curve obtained under those conditions for a 20-mil sample is shown in Fig. 1.

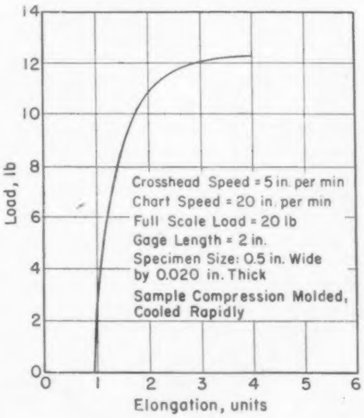

Fig. 1.—Load-Elongation Curve of High Pressure Polyethylene Obtained on the Instron Tension Testing Machine.

As can be seen, considerable error can be introduced in drawing the initial tangent to the curve. The slope of the curve changes continuously, and the location of the tangent, therefore, is a matter of judgment. Also, the slope is so steep that a small error in strain results in a large error in modulus.

To eliminate these sources of error, tests were run with various combinations of crosshead speed and chart speed. A set of conditions was sought which would give a curve with an initial straight-line portion so that the initial tangent could be drawn with greater certainty. Also a lower slope of this tangent was desired—ideally about 45 deg to minimize the error involved in drawing the line. Carey had reported that initial tangent modulus could be obtained by plotting the logarithm of the secant modulus at various strain levels

C. H. ADAMS, group leader and technical service supervisor, Research Dept., Plastics Div., Monsanto Chemical Co., Springfield, Mass., is chairman of the American Group for ISO/TC 61, a member of the Executive Committee of the ASME Rubber and Plastics Div., and active in ASTM Committee D-20 on Plastics. He has published extensively in the field of plastics testing.

ROSS H. SUPNIK, plastics engineer, Foster Grant Co., Leominster, Mass., is a member of the Society of Plastics Engineers, the American Chemical Society, and the American Institute of Chemical Engineers, and while a member of the research staff at Monsanto, was active in ASTM Committee D-20 in polyethylene work.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the ASTM D-20 Meeting in Cincinnati, Nov. 19, 1955.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] Tentative Method of Test for Tensile Properties of Thin Plastic Sheets and Films, 1955 Book of ASTM Standards, Part 6, p. 222.

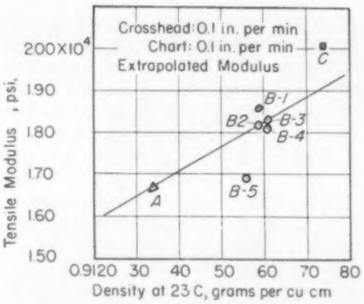

Fig. 2.—Tensile Modulus *versus* Density for Polyethylene Resins.

versus strain and extrapolating the straight line obtained to zero strain (**2**). This technique was also investigated.

Under no combination of crosshead speed and chart speed was a curve obtained with an initial straight-line portion. The best results were obtained with a crosshead speed of 0.1 in. per min and a chart speed of 1 in. per min. At this speed, the curve sloped off more gradually, and the extrapolated modulus appeared most reproducible. This was the only speed at which log modulus *versus* strain approached a straight line. At higher crosshead speeds, the plot was a curve or two straight lines.

Apparent Accuracy at Lower Crosshead Speed

A series of resins of various densities was run at 0.1 in. per min. The densities of these samples had been determined 24 hr after the samples were molded. The samples were placed in the standard ASTM atmosphere room (23 C, 50 per cent relative humidity), for several days thereafter. The extrapolated tensile modulus was plotted *versus* density as shown in Fig. 2. The modulus appeared to be a linear function of density, with possibly a steeper slope among the B type resins alone. (Type B resins were Monsanto experimental materials.) Reproducibility from specimens of the same molded slab was good. Since modulus was expected to increase as crystallinity or density increased, results looked quite reasonable.

Crystallinity versus Time After Molding

As a check on the observed relationship of modulus to density, slabs were molded from the same resins and the modulus, E, was determined again, this time 24 hr after molding. All E values were lower by about 4000. These samples were not conditioned as long as the previous set, and their lower E values were attributed to the lower density of the material developed in the shorter time interval after molding. To establish the rate of change of density with time after molding, density measurements were made at various times as shown in Fig. 3. Two 20-mil 6 by 6-in. slabs were compression molded from each of three commercial resins. Density was run on one strip from each slab at various time intervals, while checks were made on other strips at random.

Sources of Variability

As can be seen from Fig. 3, the density increases significantly the first few days after molding and levels off after about three days. For the sake of uniformity, all modulus and density measurements must be made after an identical conditioning period. All specimens were, therefore, arbitrarily conditioned exactly 24 hr (at 23 C and 50 per cent relative humidity) before being tested. Thus, speed of testing and time of conditioning had been established. The subsequent course of the modulus technique development involved a study of several factors:

1. Length of sample in grips,
2. Position of slab in press,
3. Method of mounting,
4. Effect of gage length, and
5. Adjustment of gage

The experimental work which assessed the importance of these factors as additional sources of variability is described briefly.

Length of Sample in Grips.—To get some idea of test reproducibility within samples and between operators and to check the uniformity of the molded sheet, an experiment was designed as shown in Table I. Two operators each tested three slabs. Three specimens from each slab were cut parallel to the sides of the press and three were cut perpendicular, designated long and short respectively. After three $\frac{1}{2}$-in. strips were cut in one direction, the strips cut in the perpendicular direction were only about 4 in. long since the sheets were 6 in. square. The 4-lb modulus, which is the secant modulus at that point on the load-elongation curve where the load is equal to 4 lb, was used as the basis of comparison.

TABLE I.—FOUR-POUND MODULUS OF POLYETHYLENE RESIN B-3, psi.

Slab	Operator I		Operator II	
	Long	Short	Long	Short
No. 1..	13 600	9 400	11 800	10 800
	12 100	8 000	13 000	9 600
	14 300	8 800	11 200	10 300
No. 2..	14 900	9 400	11 200	10 000
	15 400	8 800	15 200	10 000
	13 600	8 900	11 900	8 200
No. 3..	12 200	8 800	8 900	9 400
	13 700	9 400	10 200	8 800
	12 600	9 000	10 000	9 000

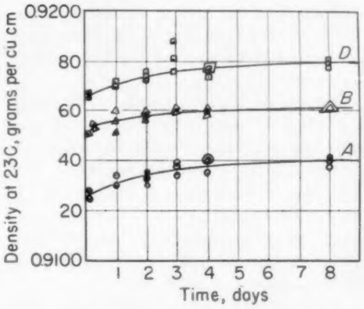

Fig. 3.—Density *versus* Time After Molding for Polyethylene Resins.

Results showed a significant difference between long and short strips. Also, operator I obtained higher values for the long strips than operator II. Both had more variation in the long strips than in the short ones.

It was found that operator II held the long specimens taut when tightening the lower grip, while operator I did not. Slack in the strip would result in a lower indicated strain and a higher modulus. Greater variability in the long samples may possibly be attributed to nonuniformity in thickness of end strips caused by shrinkage. (One long strip from each set had been cut from the end of the sheet.) The lower values of the short strips were felt to be due to slippage in the grips. A certain amount of slippage always occurs with this type of gripping system, the amount of slippage being inversely proportional to the force exerted on the specimen. Force, in turn, is proportional to the surface area of the strip in the jaws. Slippage would result in a larger gage length, L, than is used in the calculation:

$$E = \frac{\text{Stress}}{\text{Strain}} = \frac{\text{psi}}{\Delta L / L_0}$$

Thus the calculated modulus would be lower than the actual value. Slippage may also be accentuated by nonuniform pressure exerted by the jaws when the sample does not extend over the entire length of the jaw face.

Position in Molding Press.—To determine whether the lower modulus of the short strips was due to slippage or position in the press, two slabs were molded in positions in the press that were at right angles to each other. Strips were numbered from left to right and alternate strips were cut down to 4 in. by removing 1 in. from each end. Results led to the following conclusions:

1. Low modulus of shorter samples was not due to direction of cutting but was probably caused by slippage.

2. Outside strips were all extreme values as observed previously.

A plot of log secant modulus *versus* strain is shown in Fig. 4 for three long strips and three short strips from one of these slabs.

Method of Mounting.—To investigate the effect of mounting the specimen, a slab was molded and cut into nine specimens numbered from left to right. The first four were held taut while tightening the lower grip; the last five were not. Much smaller variation was noted in the taut samples. Also, end strips gave extreme values in each case.

Next the specimen was inserted so that it was flush with the top edge of the upper grip. Since the length of each jaw face was 2 in. and the gage length was 2 in., the 6-in. specimen was held taut by flash protruding out the bottom of the lower grip. In the experiment shown in Table I operator II had no flash and, therefore, dropped his specimens $\frac{1}{2}$ in. from the top edge of the grip to have enough protruding out the bottom to hold. The effect of dropping the specimen was found by positioning four strips of a slab flush with and four of the same slab dropped $\frac{1}{2}$ in. from the top edge of the upper grip. All the dropped samples showed lower modulus values than the ones flush with the top. Here again, smaller area in the grips results in less force and possible nonuniform force on the sample causing more slippage.

Effect of Gage Length.—Results cited in Table I brought attention to the effect of gage length. To use a 6-in. strip and still have $\frac{1}{2}$ in. protruding out the bottom edge of the lower grip, the gage was decreased from 2 to $1\frac{1}{2}$ in. Modulus values were significantly higher. Close perusal of the equation for strain,

$$\epsilon = \frac{\Delta L}{L}$$

reveals that a change in gage, L, results in an effective change in rate of straining since ΔL is determined by the crosshead speed, which is held constant. End effects (slippage, etc.) are also affected somewhat by change in gage. All specimens must, therefore, be run with identical gage length for comparable results.

Adjustment of Gage.—Additional improvement in precision and accuracy of results was obtained by standardizing the procedure for setting the gage length of the machine. Because of parallax and errors in judgment, use of a ruler held to the sides of the jaws is inadequate. A metal gage placed between the jaws allows for good reproducibility —or setting the gage directly by use of machine dials is recommended.

Five per cent Secant Modulus.—Throughout the investigation, a plot of log modulus *versus* strain showed smaller variability from specimen to specimen

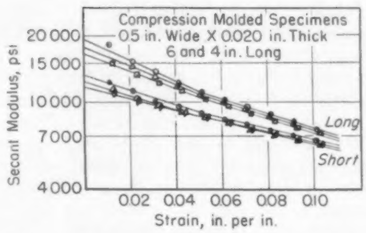

Fig. 4.—Secant Modulus *versus* Strain for Polyethylene Resin B-3.

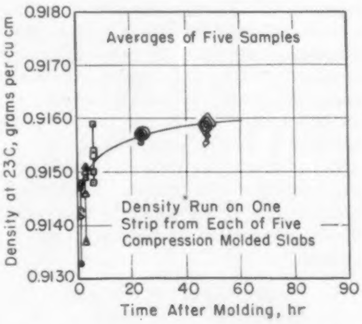

Fig. 5.—Density *versus* Time After Molding for Polyethylene B-3.

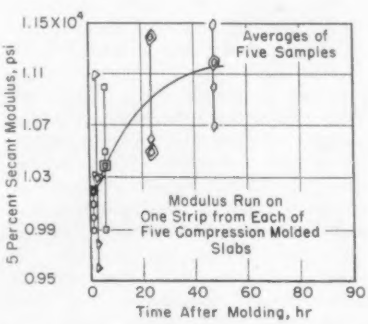

Fig. 6. Five per cent Secant Modulus *versus* Time After Molding for Polyethylene Resin B-3.

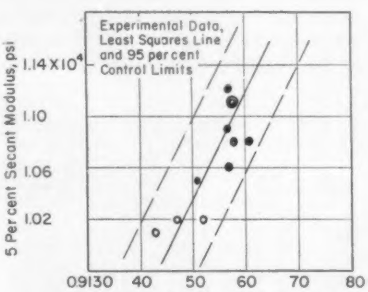

Fig. 7.—Five per cent Secant Modulus *versus* Density for Polyethylene Resin B-3.

at 5 per cent strain than at smaller strain. For example, in Fig. 4 the lines appear to converge at about 5 per cent strain. Consequently, 5 per cent secant modulus was chosen as a convenient relative standard in reporting data.

Reproducibility.—An experiment was designed to measure reproducibility within samples and between operators (see Table II). Three operators each checked three slabs, and again the effect due to position in press was checked. Data are averages of 5 strips from each slab. Analysis of these results shows excellent reproducibility from slab to slab and operator to operator. Position in the press is not significant.

The results of these variability studies were incorporated in the Improved Method for Determining Tensile Modulus of Polyethylene presented in the Appendix.

Tensile Modulus *versus* Density

With this improved procedure for measuring tensile modulus, it became possible to study the relationship of modulus to density and time after molding.

Resin B-3

Five 20-mil sheets of B-3 resin were compression molded, and each was cut into nine $\frac{1}{2}$-in. strips. Specimens were numbered from left to right, and end ones discarded. One specimen of each slab was retained for density measurements, while another of each slab was taken at random for modulus determinations. Averages of the five density values are plotted *versus* time in Fig. 5. Averages of the five modulus values are plotted *versus* time in Fig. 6.

Averages of modulus were plotted *versus* averages of density for each time interval. Additional data were similarly obtained for other time periods, and the correlation coefficient for a linear relationship was found to be very high. The least squares equation and 95 per cent control limits are plotted in Fig. 7 along with the observed data.

Other Resins

Simultaneous modulus-density measurements were made on resins A, C, B-2 and B-5 at 3 and 47 hr after molding to see if values fell along the curve calculated for B-3. An average of five values was obtained for each slab. Modulus changed very little with density in the 3-hr run, whereas the slope of the line in the 47-hr run was close to that of B-3. All points except one were outside the 95 per cent limits of the *E-D* curve for B-3. However, a $1\frac{1}{2}$-in. gage was used instead of the usual 2-in. gage, and this resulted in a greater straining rate on

the samples, as discussed previously. Consequently, the experiment was repeated with a 2-in. gage length. Other resins were included as shown in Table III. All the B's except B-6 were inside the B-3 limit for the 3-hr run. However, they were all outside in the 48-hr run.

To determine whether specific resins possessed different modulus-density curves, modulus and density were measured simultaneously at the same time intervals after molding as had been used for B-3. Results are shown in Table IV. Data were obtained at 3, 6, 24, 48, and 96 hr after samples were molded. All the values appeared to be on the same curve. In fact, the correlation coefficient for a linear relationship of E and D for all materials tested was very high.

In Table V are shown the least squares equations for calculating density from modulus, the correlation coefficients and 95 per cent limits for the three resin classifications: B-3, all B's, and all resins tested. While the linear correlation is very strong for all resins and for B-3 alone, it is only moderate in the case of the various lots of B-type resins.

TABLE III.—MODULUS-DENSITY MEASUREMENTS OF POLYETHYLENE RESINS MADE 3 AND 48 HR AFTER SAMPLES WERE MOLDED.

Resin	3 hr		48 hr	
	Density, g per cu cm	Five per cent Secant Modulus, psi	Density, g per cu cm	Five per cen Secant Modulus, psi
A.....	0.9124	9 5000	0.9132	10 400
B-2...	0.9151	10 600	0.9157	11 900
B-5...	0.9154	10 800	0.9158	11 900
B-6...	0.9145	10 900	0.9152	11 700
B-7...	0.9145	10 600	0.9153	11 800
B-8...	0.9148	10 200	0.9153	11 500
B-9...	0.9149	10 100	0.9154	11 400
C.....	0.9147	11 800	0.9177	12 400
D.....	0.9203	15 400	0.9212	16 400

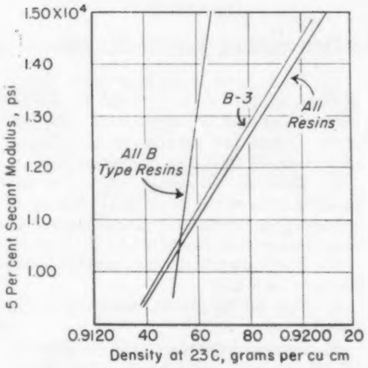

Fig. 8.—Least Squares Lines to Determine Density from Modulus for Polyethylene Resins.

The least squares lines are drawn in Fig. 8. The B-3 line has approximately the same slope as the all-resins line, while the line for all type B resins has a much steeper slope. However, as shown in Table V the confidence level for linear correlation is only 90 per cent.

Discussion

The standard deviation obtained with the improved procedure for measuring tensile modulus is less than ± 6 per cent. The same factors contributing to improved precision of modulus results for polyethylene apply to other flexible films as well. Adoption of the same procedure for determining tensile modulus of all nonrigid materials can, therefore, be expected to yield more reproducible and more meaningful data.

While the linear relationship of modulus to density is very high for all resins and for B-3 alone, it is only moderate in the case of the various B-type resins. This is due to greater variability in the data and may possibly be attributed to differences in short chain branching among the different lots of resin. According to the literature (**1**, **3**, **4**) the nature of the crystallization process is complex. When a specimen is cooled from the melt, portions of molecular chains align themselves together to form crystallites. The distribution and size of these crystallites as well as their arrangement probably have a definite effect on physical properties. The pattern of crystallization can well be affected by molecular structure degree and type of branching, amount of crosslinking, impurities, etc. Variation among lots of B-type resin has been observed in other respects, so that variation in modulus is not surprising.

On the other hand, the variability among B-type resins blends in nicely with the variation in the other resins. The correlation coefficient for a linear relationship of modulus and density for all materials tested was very high. This indicates an inherent variability for all polythylenes, and the statistical limits for material prepared by each manufacturing process should be determined individually.

The linear relationship of modulus to density can be useful in predicting either of these properties when the other is known.

Conclusion

This test is used to study the relationship of modulus to density for commercially available polyethylene resins. Modulus is shown to increase during the first few days after samples were molded.

Modulus is shown to be a linear function of density.

Acknowledgment:

Sincere thanks are due to the Polyethylene Processing Group of Monsanto Chemical Co.'s Plastics Division for their interest and assistance throughout this study. Also appreciation is given Mrs. Helen Lata, Laboratory Assistant in the Research Department, who obtained much of the experimental data.

TABLE IV.—MODULUS AND DENSITY OF POLYETHYLENE RESINS AT VARIOUS TIMES AFTER MOLDING.

Time After Molding, hr	Resin B-6		Resin C		Resin A		Resin D	
	Density, g per cu cm	E, psi	Density, g per cu cm	E, psi	Density, g per cu cm	E, psi	Density, g per cu cm	E, psi
3.......	0.9151	10 200	0.9166	11 400	0.9130	9 500	0.9214	15 200
6.......	0.9153	10 300	0.9167	11 500	0.9132	9 700	0.9213	15 200
24.......	0.9157	11 200	0.9166	12 200	0.9137	9 800	0.9215	16 000
48.......	...		0.9182	12 500	0.9136	10 100	0.9220	15 600
96.......	0.9160	11 500	0.9182	13 300	0.9141	10 700	0.9217	13 900

TABLE V.—STATISTICAL RELATIONSHIP OF MODULUS TO DENSITY FOR POLYETHYLENE RESINS.

Resin Classification	Least Squares Equation[a]	Correlation Coefficient, R	Degrees of Freedom	Confidence Level for 99 per cent Probability	3σ Limits
B-3........	$X = 0.9030 + 1.16(10^{-6})Y$	0.82	9	0.73	0.00076
All types....	$X = 0.9021 + 1.26(10^{-6})Y$	0.94	49	0.36	0.00139
All B's......	$X = 0.9123 + 0.29(10^{-6})Y$	0.37	27	0.45	0.00096

[a] X = density at 23 C, g per cu cm. Y = 5 per cent secant modulus, psi.

References

(**1**) R. B. Richards, "Polyethylene—Structure, Crystallinity and Properties," *Journal of Applied Chemistry*, Vol. I, p. 370 (1951).

(**2**) R. H. Carey, "The Mechanical Properties of Polyethylene," *Journal*, Soc. Plastics Engrs., Vol. 16, p. 10 March, 1954.

(**3**) C. A. Sperate, W. A., Franta. and H. W. Starkweather, Jr., "The Molecular Structure of Polyethylene. V. The Effect of Chain Branching and Molecular Weight on Physical Properties," *Journal*, Am. Chemical Soc., Vol. 75, p. 6127 (1953).

(**4**) W. M D. Bryant, "Polyethylene Fine Structure," *Journal*, Polymer Science, Vol. 2, p. 547 (1947).

APPENDIX

Improved Method for Determining Tensile Modulus of Polyethylene Resins

Scope and Significance

This method is designed for use in determining the comparative tensile modulus of polyethylene resins. Samples are all in the form of thin film prepared the same way and run under one set of machine conditions. The test is intended to aid in characterizing these materials and as such, may be used as a control measure in their manufacture and fabrication.

Sample Preparation

1. Place 15 g of resin in a mold consisting of two press polish plates with a spacer 6¼ in. long by 6¼ in. wide by 0.020 in. thick. A dispersion of zinc stearate in xylol wiped on metal surfaces may be used to prevent sticking.

TABLE II.—5 PER CENT SECANT MODULUS OF POLYETHYLENE RESIN B-3 OBTAINED 3 HR AFTER MOLDING, psi.

Direction of Cutting Specimens	Slab	Operator A	Operator B	Operator C
Parallel to sides of press......	No. 1	10 400	10 500	9 700
	No. 2	10 200	10 100	10 000
	No. 3	10 000	10 300	10 000
Perpendicular to sides of press........	No. 1	10 400	10 100	10 000
	No. 2	10 300	10 500	10 000
	No. 3	10 400	10 000	10 100

[3] Tentative Method of Test for Tensile Properties of Plastic, 1955 Book of Standards, Part 6, p. 207.

2. Place mold in an 8 by 8-in. platen press with 3-in. diameter ram or similar compression molding apparatus. Be sure press platens are parallel to avoid nonuniformity in thickness of molded slab.

3. Turn on full steam. Apply 50 psi molding force on the stock (gage reading = 1 ton on 3-in. diameter ram) until temperature of platen reaches 320 F.

4. Maintain this temperature and pressure for 5 min.

5. Shut off the steam; turn on cooling water.

6. Increase pressure to 775 psi (gage = 15 tons); hold until temperature drops to 257 F.

7. Increase pressure to 1025 psi (gage = 20 tons). Remove molded slab after it has cooled to room temperature.

8. Cut into nine ½-in. strips. Be sure cutter edges are parallel and free of nicks. Use the center five. Discard the two end strips because of possible nonuniformity due to shrinkage.

Conditioning

9. Condition 24 hr at 23 ± 1.1 C and 50 ± 2 per cent relative humidity. Exact timing is necessary since modulus increases with time during the first 72 hr after molding.

Apparatus

10. An Instron tension testing machine (or other suitable film testing machine having a constant rate of crosshead speed) equipped with flat, smooth steel grips 2 in. long.

Procedure

11. Set the machine conditions as follows:

Crosshead speed, in. per min...........	0.1
Chart speed, in per min................	1.0
Full scale load, lb....................	20
Gage length, in........................	2

To assure uniform gage setting, adjust the grip separation with the machine dials or with a standard gage placed in the jaw grips. Caliper adjustment or ruler alignment is not adequate. Be sure grips are in the same vertical plane.

12. Mark the 2-in. portion that is to be stretched on each strip, and measure the thickness within this length. In case of variation use the average thickness to calculate modulus.

13. Insert the strip so that the sample is flush with the top edge of the upper grip. With a 2-in. gage length ¼ in. will protrude out the bottom of the lower grip.

14. Hold the strip taut with the protruding portion while tightening the lower grip. This eliminates slack and improves the precision of the test. Do not apply any appreciable load.

Calculations

15. Calculate the 5 per cent secant modulus (ASTM Method D 638,[3] Appendix) by dividing the stress at 5 per cent strain by 0.05. Express results to 3 significant figures and report average, range, and standard deviation.

International Committee on Cellulose Analysis (ICCA)

For several years cellulose chemists in several countries have endeavored to establish an organization by which they could exchange information on cellulose technology and, particularly, methods of analysis. The first meeting of such a group was held in Stockholm in August, 1953, at which time discussions were held on the problems in this field and a formal organization of an international committee was proposed.

The 130th Meeting of the American Chemical Society in Atlantic City, September 16–21, provided the occasion for representatives from other nations to meet with ASTM Committee D-23 on Cellulose and to work out a formal organization for an international committee. At its organization meeting the international group elected Miss Karin Wilson of Sweden, chairman; R. Bartunek of West Germany, vice-chairman; and W. W. Becker, U.S.A. secretary. International Committee on Cellulose Analysis (ICCA) was approved as the official name. The committee will exchange information on cellulose analytical methods among the members, with the objective of eventually establishing international standard methods for cellulose.

The group discussed the desirability of affiliating with the International Organization for Standardization, and while no definite recommendation was made it was understood that the chairman of ICCA would approach the ISO to explore the matter of establishing a technical committee on cellulose within the ISO.

Among the countries represented at the organization meeting were Canada, Finland, West Germany, Great Britain, Japan, Sweden, and the U.S.A. The U. S. representatives included members of ASTM Committee D-23, the American Chemical Society, and the Technical Association of the Pulp and Paper Industry.

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

Harold Allen has been named chief of the Physical Research Branch of the Research Division, National Bureau of Standards. With the Bureau since 1937, he served as chief of the Soils Section of the Physical Research Branch for a number of years, and more recently as chief of the Nonbituminous Section. Mr. Allen, who has a broad knowledge of the properties and uses of highway construction materials, has participated in ASTM technical activities for many years. He also has been active in technical committee work of the Highway Research Board, the American Association of State Highway Officials, the American Concrete Institute, and the American Society of Civil Engineers. In recognition of valued contributions, ASTM Committee D-18 on Soils for Engineering Purposes recently elected Mr. Allen to honorary membership in their group.

Past-President **L. C. Beard**'s office is now in the new Socony Mobil Building at 150 E. 42nd St., New York 17, N. Y. The company moved into its new offices there in September after being at 26 Broadway for many years.

Max I. Beard, formerly with Westinghouse Electric Corp., Atomic Power Div., Pittsburgh, Pa., is now purchasing engineer with Caterpillar Tractor Co., East Peoria, Ill.

Oliver P. Beckwith, until recently with Fabric Research Laboratories, Inc., Dedham, Mass., is now in charge of quality control, The William Carter Co., Needham Heights, Mass. Mr. Beckwith has been serving as secretary of Committee E-11 on Quality Control of Materials since its organization in 1946.

Don Blackmar, formerly with Modine Mfg. Co., Racine, Wis., has been appointed chief metallurgist, Le Roi Division, Westinghouse Air Brake Co., Milwaukee, Wis. He will be in charge of the newly established Le Roi metallurgical and chemical laboratory, part of the $5,500,000 engineering and research expansion announced by Le Roi last spring.

Charles V. Collier, until recently with Lone Star Brewing Co., San Antonio, Tex., is now senior research chemist, Research and Development Group, American Potash and Chemical Corp., Los Angeles, Calif.

Raymond M. Conner has retired as consultant for the American Gas Assn. Laboratories, Chicago, Ill. During 41 years of distinguished service to the American gas industry he had made many contributions to the growth of national standards for gas appliances and accessories. After more than 22 years as director of the AGA Laboratories, Mr. Conner was obliged to relinquish active participation in 1947 because of illness; however, he had continued as consultant until his recent retirement. He has been a member of ASTM Committee D-3 Gaseous Fuels for many years; he served as the first secretary of this main group from 1935 to 1947.

William A. Dupraw, formerly research analytical chemist, Department of Chemistry and Chemical Engineering, Armour Research Foundation, Chicago, Ill., is now chief chemist, NRC Metals Corp., Cambridge, Mass.

Benson L. Dutton has resigned as chairman of the Engineering School at the Tennessee Agricultural and Industrial State University, Nashville, to accept appointment as supervising engineer in the Bridge Design Section, Department of Streets, City of Philadelphia. Mr. Dutton established the engineering program now in existence at the college, and also has practiced as a consulting structural engineer in Nashville.

Bram C. Feldman, until recently chief engineer with the Interelectric Corp., Warren, Pa., is now general engineer with the Corps of Engineers, U. S. Department of the Army, Fort Belvoir, Va.

Morris Goodkind, consulting engineer, Bloomfield, N. J., and former director and chief bridge engineer of the New Jersey State Highway Department, was honored with the 1956 Engineering Award by the New Jersey Society of Professional Engineers for outstanding achievements in bridge design and contributions to the advancement of the engineering profession.

William H. Graves, retired vice-president and director of engineering, The Studebaker-Packard Corp., Detroit, Mich., has been elected to the Board of Directors, The American Forging and Socket Co., Pontiac, Mich.

Joseph E. Gray has been named engineering director of the National Crushed Stone Assn., Washington, D. C., succeeding **A. T. Goldbeck,** recently retired. Mr. Goldbeck, who will continue with the Association as engineering consultant, is an ASTM honorary member and former Director of the Society. He has recently been elected an honorary member of Committee C-9 on Concrete and Concrete Aggregates. He had been elected to honorary membership in Committee D-4 on Road and Paving Materials in 1954. Mr. Gray, who has been connected with NCSA since formation of its research laboratories in 1928, is also active in ASTM committee work, serving on Committees C-7 on Lime, C-9 on Concrete Aggregate, C-12 on Mortars for Unit Masonry, and D-4. Both Messrs. Goldbeck and Gray have served on the ASTM Washington, D. C., District Council.

W. F. Griffin, formerly with Westinghouse Electric Corp., Bath, N. Y., is now senior engineer, Radio Corporation of America, Harrison, N. J.

Martin H. Gurley, Jr., has accepted a position as manager of Textile Div., Thermoid Co., Trenton, N. J. Until recently he was associated with The Duplan Corp., Winston-Salem, N. C.

Henry J. Jacobson, formerly with Sutherland & Jacobson, Fort Thomas, Ky., is quality control manager, P. R. Mallory Co., Inc., Indianapolis, Ind.

Barclay Gibbs Jones, until recently research assistant, University of North Carolina, Chapel Hill, is now on the teaching staff of the University of California, Department of City and Regional Planning, Berkeley.

Earl F. Kelley recently retired as chief of the Physical Research Branch, Research Division, National Bureau of Standards. Very active in ASTM technical work for the past thirty years, Mr. Kelley was honored in 1954 with an ASTM Award of Merit, recognizing distinguished service in the field of highway materials, including concrete pipe, and sustained support of other ASTM activities. He is a former chairman of the ASTM Washington, D. C., District Council. Mr. Kelley resides at 7009 Maple Ave., Chevy Chase, Md.

S. C. Massari has returned to the American Foundrymen's Society as technical director, after an absence of three years spent in industry. Prior to 1946 when he originally joined AFS, Mr. Massari was chief metallurgist in charge of research with the Association of Manufacturers of Chilled Car Wheels for 18 years. He resigned his position as director of research for National Engineering Co., Chicago, to rejoin AFS.

(Continued on page 80)

PROFESSIONAL CARDS

PROFESSIONAL CARDS

OTHER SOCIETIES' EVENTS

November 12–15—**American Petroleum Inst.**, Annual Meeting, Conrad Hilton Hotel and Palmer House, Chicago, Ill.

November 14–17—**Society of Naval Architects & Marine Engineers**, Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

November 15–17—**Acoustical Society of America**, Los Angeles, Calif.

November 22–30—**American Association of State Highway Officials**, Annual Meeting, Atlantic City, N. J.

November 23–24—**American Physical Society**, Chicago, Ill.

November 25–28—**American Society of Refrigerating Engineers**, Semi-annual Meeting, Statler Hotel, Boston, Mass.

November 25–30—**American Society of Mechanical Engineers**, Annual Meeting, Statler and McAlpin Hotels, New York, N. Y.

November 25–30—**American Rocket Soc.**, Annual Meeting, McAlpin Hotel, New York, N. Y.

November 26–30—**National Exposition of Power and Mechanical Engineering**, New York Coliseum, New York, N. Y.

November 26–30—**Third International Automation Exposition**, Trade Show Building, New York, N. Y.

November 27—**American Institute of Consulting Engineers**, Annual Dinner, Waldorf-Astoria Hotel, New York, N. Y.

November 27–30—**American Chemical Soc.**, National Chemical Exposition, Public Auditorium, Cleveland, Ohio.

November 28–29—**Third International Automation Exposition**, Trade Show Building, New York, N. Y.

December 9–12—**American Institute of Chemical Engineers**, Annual Meeting, Hotel Statler, Boston, Mass.

December 26–31—**American Association for the Advancement of Science**, National Meeting, Statler, Gov. Clinton, and McAlpin Hotels, New York, N. Y.

January 14–16, 1957—**National Symposium on Reliability and Quality Control in Electronics**, Hotel Statler, Washington, D. C., sponsored jointly by ASQC, IRE, AIEE, and RETMA.

January 16–18, 1957—**Society of Plastics Engineers, Inc.**, Annual Technical Conference, Sheraton-Jefferson Hotel, St. Louis, Mo.

Kodak reports to laboratories on:

the 40th edition of the Eastman Organic Chemicals Catalog . . . how to draw a crowd into your tent . . . a material to coat a pattern on metal

Our sweet laborers *have finished the task of preparing the address labels. By now "Eastman Organic Chemicals, List No. 40" should have reached all who have in years past indited a desire to keep receiving each new edition of the catalog of the 3500-odd reagents and other organic compounds quickly available in laboratory quantities from a single source of known integrity. Others who want the new catalog should address* Distillation Products Industries, *Eastman Organic Chemicals Department, Rochester 3, N. Y.* (*Division of Eastman Kodak Company*).

Slowdown in color

In the heat of debate we once heard an advertising man cry out, "What's a product? Anybody can make a product. The real art is selling a product."

Though since moved on to fields where his artistry could more lushly flower, he wasn't entirely wrong, just too sweeping in his value judgments. In the market place—particularly in the industrial market place—many a wonderfully ingenious and efficient product of the engineering mind and hand fails to ring the bell as loud and clear as expected, simply because too few potential customers know how the thing works.

One way to draw a crowd into the tent for educational purposes is to show them movies. Showmanship isn't all; some mechanisms can be seen at work in no other way than through movies which slow down the action fifty times or more. Sometimes recognition of this is all the showmanship needed.

There was a time when these high speed movies were used only for development and trouble-shooting. Long miles of high speed film still quite justify themselves in the form of black-and-white rush negatives shown once to taut little engineering groups, but more and more high speed shooting is done in *Kodachrome Film* and even on *Commercial Kodachrome Film*, which is chosen only with advance knowledge that numbers of full-color copies will be required for circulation.

"High Speed Motion Pictures," a new booklet obtainable from Eastman Kodak Company, Sensitized Goods Division, Rochester 4, N. Y., tells about the Kodak High Speed Camera *and about the films spooled for this kind of movie making.*

Mr. Gabler beats the glue

You should see what a fine job Bob Gabler has been doing lately in converting the steel industry over to *Kodak Photo Resist*. Who is Bob Gabler? A man we keep in Pittsburgh to help work out any photographic ideas that come up in the various industries there. What is *Kodak Photo Resist?* A liquid which quickly hardens to a tough, tenacious coating on metal, but only in areas where bright light has hit it before flushing with a certain solvent called *Kodak Photo Resist Developer*.

Before Mr. Gabler showed *Kodak Photo Resist* to the men who make the tensile measurements on sheet steel, they had mostly been using old-fashioned bichromated glue as the light-sensitive substance for photographically printing a measurement grid onto their samples before deformation. Bichromated glue is not nearly as light-sensitive as *Kodak Photo Resist*, but more annoying to the steel testers is its tendency to flake off in the test instead of stretching with the metal the way a grid pattern of *Kodak Photo Resist* does. Bob, of course, had no way of knowing in advance that *Kodak Photo Resist* would work out so well, since the product is one we thought we were making merely for photoengravers, photolithographers, and electronic-circuit printers. But when the steelmen called, he went in there pitching and everything turned out OK. That's what we pay him for.

If you have a problem for a Kodak Technical Representative like Bob Gabler or if you just want literature on Kodak Photo Resist, *write Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N. Y.*

This is one of a series of reports on the many products and services with which the Eastman Kodak Company and its divisions are . . . *serving laboratories everywhere*

FOR FURTHER INFORMATION CIRCLE 301 ON READER SERVICE CARD PAGE 105

Personals

(*Continued from page 75*)

J. W. Means has been appointed chief chemist of the Chase Bag Co.'s General Laboratory at Chagrin Falls, Ohio. With the company since 1952, Mr. Means had been assistant chief chemist since 1954.

Leonard I. Meisel, supervisor of the Plastics Branch, AML, left the Naval Air Material Center (Philadelphia) in September after 15 years' service at the Naval Air Experimental Station, transferring to the Philadelphia Quartermaster Depot to become civilian chief of the testing laboratories. Mr. Meisel is a member of ASTM Committees C-19 on Structural Sandwich Constructions and D-14 on Adhesives, representing the U. S. Department of the Navy. He resides at 5432 Locust St., Philadelphia, Pa.

Alfred S. Nemy has accepted a position as research metallurgist, Thompson Products, Inc., Cleveland, Ohio. He was formerly on the faculty of Carnegie Institute of Technology, Dept. of Metallurgical Engineering, Pittsburgh, Pa.

Nathan M. Newmark, research professor of structural engineering, has been appointed head of the civil engineering department at the University of Illinois, succeeding **W. C. Huntington** who retired on completion of 30 years as head of the department. Professor Newmark is an authority on structural analysis and design, including elastic theory, arch bridges, concrete bridge floors, and the effects of bombs and earthquakes on structures.

Bror Nordberg, until recently editor, *Rock Products*, Chicago, Ill., is now associated as vice-president with the Azbe Corp., St. Louis, Mo., consulting engineering firm serving the lime and related industries.

Howard F. Peckworth, managing director, American Concrete Pipe Assn., Chicago, Ill., has been elected a director of the American Society of Civil Engineers for a three-year term.

John S. Pettibone, who served as an assistant technical secretary with ASTM for seven years, recently joined the staff of the Bayonne (N. J.) Research Laboratory of The International Nickel Co., Inc. He will be associated with the section both as a technical writer and as a research chemist; and will represent International Nickel on ASTM Committees A-5 on Corrosion of Iron and Steel, and B-3 on Corrosion of Non-Ferrous Metals and Alloys. Mr. Pettibone is immediate past chairman of the Philadelphia Section of the National Association of Corrosion Engineers.

Theodore O. Reyhner, formerly on the faculty of Michigan College of Mining and Technology, Houghton, is now professor, Engineering Dept., Chico State College, Chico, Calif.

(*Continued on page 82*)

THE SARGENT ELECTRIC DRYING OVEN . . . .

The Sargent electric drying oven was designed to fill the need of chemists for a dependable, low-cost, automatically controlled oven with a long service life. That it has achieved this objective is evidenced by the fact that thousands of these ovens are now in use in laboratories all over the world.

THE MULTIPLE CHROMEL WIRE HEATING ELEMENTS are arranged to give even heat distribution throughout the entire oven.
THE VENTILATING SYSTEM provides rapid transfer of air through the oven, which results in an exceptionally fast drying rate.
THE METAL WALLS are lined with 1/4" Transite, to prevent excessive heat loss and the bimetallic thermostat maintains the heat in the oven to within ±1° C. of the desired temperature.
THE OPERATING RANGE is from slightly above room temperature to 200° C. (392° F.).
ALL CONTROLS—the three heat switch—the thermostat control and the pilot light—are located on the front panel which is actually the front of a drawer on which the heating elements are mounted. By removing two screws at each end of the panel the entire heating and control systems can be removed from the oven as a single unit.
MAXIMUM POWER CONSUMPTION 850 watts. Dimensions: Outside, 16" x 11¾" x 11⅞". Inside 9" x 11¼" x 11¼".

S-63995 OVEN—Sargent, Gravity Convection, Electric Thermostatic, 200° C. With two metal shelves, thermometer (—10° C to 200° C in 1° subdivision), cord and plug for standard 115 volt, A.C. or D.C. circuits.................**$55.00**

S-64005 Ditto. But for operation from 230 volt, A.C. or D.C. circuits.................**$55.00**

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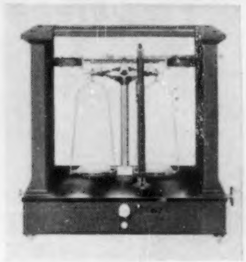
SOUTHEASTERN DIVISION, 3125 SEVENTH AVE., N., BIRMINGHAM 4, ALA.

CIRCLE 303 ON READER SERVICE CARD PAGE 105

the laboratory "WORKHORSE"

AINSWORTH CHAINWEIGHT BALANCE



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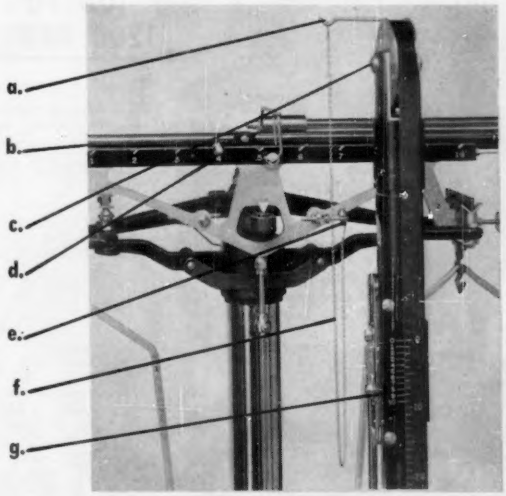

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CIRCLE 304 ON READER SERVICE CARD PAGE 105

Personals

(*Continued from page 80*)

Frank E. Richart, Jr., of the Department of Civil Engineering, University of Florida, Gainesville, and Allen J. Curtis, lecturer in engineering at the University of California, were honored by the American Society of Civil Engineers with the Thomas A. Middlebrooks Award for an outstanding published paper by the ASCE mechanics and foundation division.

Louis J. Rohl has been elected vice-president and chief metallurgical engineer, U. S. Steel Corp., Pittsburgh, Pa. He had been chief metallurgical engineer.

Milton A. Sanders, recently chief research engineer at the Sun Tube Corp., Hillside, N. J., a division of Bristol-Myers Co., has joined the field sales staff of the Plastics Molding Equipment Div., F. J. Stokes Corp., Philadelphia, Pa. (he will work out of the New York district office). Mr. Sanders is a liaison representative of the Society of Plastics Engineers on ASTM Committee D-20 on Plastics.

R. H. Sawens, who represented the Solvay Process Div., Allied Chemical & Dye Corp., Syracuse, N. Y., on Committee D-12 on Soaps and Other Detergents since 1937, has retired. He is replaced on this group by **Walter A. Reissig.**

Gordon H. Silver, formerly with Titeflex, Inc., Springfield, Mass., is now metallurgist, Control Engineering Unit, Detroit Controls Corp., Norwood, Mass.

Forrest A. Simmonds of the U. S. Forest Products Laboratory left Madison (Wis.) September 3 for a 5-month assignment as pulp and paper consultant to the Philippine Institute of Forest Products Research which is being established near Manila. Enroute he visited a new semichemical pulp mill in Osaka, Japan. During his stay in the Philippines, which is being sponsored by the Food and Agriculture Organization of the United Nations, Mr. Simmonds will help develop a research program for the Institute and train Filipino scientists in research techniques in the field of pulp and paper. The Philippines have large hardwood resources, but most of the country's pulp and paper is imported, and one of the first jobs of the Institute will be to investigate the pulping characteristics of the available species. Mr. Simmonds is chairman of Committee D-23 on Cellulose and Cellulose Derivatives. His Philippine address will be: Institute of Forest Products Research, College, Laguna, Philippines.

Kalman Steiner, formerly consulting engineer, C. Hoffberger Co., is now partner, Steiner Technical Writings, Baltimore, Md.

Irven Travis, who has been vice-president of research for Burroughs Corp. since 1952, has been named vice-president of research and engineering. He joined Burroughs in 1949 as director of the corporation's research activities at Paoli, Pa.

Charles J. Zusi, formerly president of Container Laboratories and sometime director of research of Hinde and Dauch Paper Co. of Canada, Ltd., and, earlier, of Atlas Plywood Corp., has established himself as a packaging consultant with headquarters at 41 Salem Lane, Evanston, Ill. Mr. Zusi has been a member of Committees D-6 on Paper and Paper Products and D-10 on Shipping Containers.

NEW MEMBERS.......

The following 66 Members were elected from August 8 to September 17, 1956, making the total membership 8545 ..... Welcome to ASTM

Note—Names are arranged alphabetically—company members first then individuals.—Your ASTM Year Book shows the areas covered by the respective Districts.

CHICAGO DISTRICT (5)

Teletypesetter Corp., E. Stanley Larson, chief, Development and Research Dept., 2752 N. Clybourn Ave., Chicago 14, Ill.

Atkins, Robert D., standards and laboratory engineer, American Hoist and Derrick Co., 63 S. Robert St., St. Paul 1, Minn.

Booren, Hal, president, ARTco, Inc., 9120 S. Park Ave., Chicago 19, Ill.

Brush, Edward E., sales manager, Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill.

Davison, Suzanne, associate professor, in charge of textile research, School of Home Economics, University of Minnesota, St. Paul 1, Minn.

Herrmann, Irving M., 2730 S. 10th St., Milwaukee 15, Wis.

Nicholas, L. J., chemist, The Pullman, Co., 11001 Cottage Grove Ave., Chicago 28, Ill.

Romanoff, Frank P., technical director, Apollo Metal Works, 6650 S. Oak Park Ave., Chicago 38, Ill.

CLEVELAND DISTRICT (4)

Aurora Gasoline Co., Soma Kurtis, director of manufacturing, 15911 Wyoming Ave., Detroit 38, Mich.

Cleveland Builders Supply Co., The, Jay C. Ehle, vice-president, 1276 W. Third St., Cleveland 13, Ohio.

DETROIT DISTRICT (6)

Ross Operating Valve Co., Carl Halpin, manager of engineering, 120 E. Golden Gate, Detroit 3, Mich.

Mills, Dudley W., sales manager, Composite Forgings, Inc., 2300 W. Jefferson, Detroit 16, Mich.

NEW ENGLAND DISTRICT (13)

Harrington, Lucelia C., analytical engineer, Pratt & Whitney Div., United Aircraft Corp., East Hartford, Conn. For mail: Maple Ave., Collinsville, Conn.

NEW YORK DISTRICT (1)

California Crude Sales Co., John W. Weaver, special representative, 1200 State St., Perth Amboy, N. J.

Electronic Fabricators, Inc., Mitchel Samuels, president, 682 Broadway, New York 12, N. Y.

King & Gavaris, Philip King, partner, 425 Lexington Ave., New York 17, N. Y. [S]*

Barker, Lincoln B., Materials and Processes Lab., General Electric Co., Schenectady, N. Y. For mail: 885 Lishakill Rd., Schenectady, N. Y.

Bettoli, Phillip S., assistant director of research, The Ruberoid Co., Research Lab., South Bound Brook, N. J.

Dorn, Charles W., textile consultant, Suite 1300, 369 Lexington Ave., New York 17, N. Y.

Graves, Floyd L., Research Service Dept., American Cyanamid Co., W. Main St., Stamford, Conn. For mail: 2 Glen Ave., Glenbrook, Conn.

Held, Kalman M., senior scientist, Technical Research Group, 17 Union Square West, New York 3, N. Y.

Hymes, I. M., project metallurgist, International Business Machines Corp., Dept. 562, South Rd., Poughkeepsie, N. Y. [A]**

Klier, Eugene P., professor of metallurgy, Syracuse University, Syracuse, N. Y.

Kozlik, Roland A., metallurgist, The International Nickel Co., Inc., 30 Oak St., Bayonne, N. J.

Marshall, Carl A., managing director, Fairmont Coal Bureau, 52 Vanderbilt Ave., New York 17, N. Y.

Pettibone, John S., Corrosion Section, The International Nickel Co., Bergen Point Station, Box U, Bayonne, N. J.

Velzy, Charles R., partner, Nussbaumer, Clarke & Velzy, 500 Fifth Ave., New York 36, N. Y.

NORTHERN CALIFORNIA DISTRICT (7)

Horner, Arthur C., consulting engineer, 4314 California St., San Francisco 18, Calif.

Thayer, Donald P., principal engineer, dam design, California State Department of Water Resources, Box 1079, Sacramento, Calif.

OHIO VALLEY DISTRICT (15)

Knopf, Daniel P., laboratory manager, Brown-Forman Distillers Corp., Louisville, Ky. For mail: 118 Beechwood Rd., Louisville, Ky.

Platz, James A., group leader, Plastics Dept. 55, North American Aviation, Inc., 4300 E. 5th Ave., Columbus 16, Ohio.

Smith, Stanley H., Jr., staff engineer, Carbide and Carbon Chemicals Co., Division of Union Carbide and Carbon Corp., Box 8361, South Charleston 3, W. Va.

PHILADELPHIA DISTRICT (2)

Eik, Christian O., plant chemist, Hercules Cement Corp., Nazareth, Pa.

Jaffe, Samuel, chief chemist, Waverly Petroleum Products Co., 3rd and Berks St., Philadelphia 22, Pa.

Quinn, John I., bridge designer, Michael Baker Associates, 19th and Derry, Harrisburg, Pa. For mail: Penn-Harris Hotel, Harrisburg, Pa.

PITTSBURGH DISTRICT (3)

Lamb, Daniel E., head of testing and textile section, Talon, Inc., Plant #4, Meadville, Pa.

ST. LOUIS DISTRICT (9)

DeJarnett, Omer W., chief control chemist, Olin Mathieson Chemical Corp., Winchester-Western Div., East Alton, Ill.

SOUTHERN CALIFORNIA DISTRICT (7)

Alesch, Charles W., design specialist, Convair, Division of General Dynamics Corp., 3165 Pacific Highway, San Diego 12, Calif. For mail: 5141 Randlett Dr., La Mesa, Calif.

Carmichael, Edward P., vice-president, Narmco, Inc., 1882 Moore St., San Diego 1, Calif.

Cromwell, Charles F., Jr., agricultural engineer, U. S. Department of Agriculture, Soil Conservation Service, Box 158, Imperial, Calif.

Griffin, Donald F., director, Engineering Materials Div., U. S. Naval Research and Evaluation Lab., Port Hueneme, Calif. For mail: 11314 Gladwin St., Los Angeles 49, Calif.

Schneeman, Justin G., president, X-Ray Products Corp., 7829 Industry Ave., Rivera, Calif. For mail: 13320 Chandler Blvd., Van Nuys, Calif.

SOUTHWEST DISTRICT (16)

Allen, C. Herbert, vice-president in charge of production, Vitalic Battery Co., Inc., 2040 Amelia St., Dallas 19, Tex. For mail: 5319 Livingston, Dallas 9, Tex.

* [S] Sustaining member.
** [A] Associate member.

(Continued on page 84)

New Members

(*Continued from page 83*)

Hunter, Homer A., owner, Homer A. Hunter Associates, Consulting Engineers, 3708 Abrams Rd., Dallas, Tex.

Texas, Agricultural and Mechanical College of, Order Librarian, College Station, Tex.

WASHINGTON (D. C.) DISTRICT (14)

Alemán, José, Plastics Section, National Bureau of Standards, Washington 25, D. C.

Lerner, Melvin, chief chemist, U. S. Customs Laboratory, 103 Gay St., Baltimore 2, Md.

Newlon, Howard, Jr., highway research engineer, Virginia Council of Highway Investigation and Research, Thornton Hall, Charlottesville, Va. [A]

WESTERN NEW YORK-ONTARIO DISTRICT (10)

Betley, John, chemical engineer, Engineering Dept., Interelectric Corp., 1401 Lexington Ave., Warren, Pa. [A]

Bowles, Roger G., purchasing engineer, Shell Oil Company of Canada, Ltd., Box 400, Terminal A, Toronto 1, Ont., Canada. [A]

UNITED STATES AND POSSESSIONS

Southwest Testing and Research Laboratory, David J. Hall, partner, Box 4962, Tucson, Ariz.

Crichton, Robert M., applications engineer, Minneapolis Honeywell Regulator Co., 2600 S. E. Belmont, Portland 15, Ore. For mail: 103 Cedar Lane, Troutdale, Ore.

Isaac, Paul H., partner, Hammond, Collier & Isaac, 4010 Stone Way, Seattle 3, Wash.

Loomer, Don M., laboratory supervisor, Salt Lake Refining Co., Box 1889, Salt Lake City, Utah.

Vance, William W., assistant secretary, B. B. McCormick and Sons, Inc., Box 248, Jacksonville Beach, Fla.

OTHER THAN U. S. POSSESSIONS

Cimento Santa Rita S. A., Fleix Baldass, chief chemist, Rau Barao de Itapetininga 275-6°, São Paulo, Brazil.

Beltranena, Emilio, chief engineer, laboratory for testing materials, Bureau of Public Works, Guatemala, 24 Calle 3-73, Guatemala City 1, Guatemala. For mail: 8a. Ave. 28-06. Guatemala City 11, Guatemala. [A]

Cotton Textiles Industries Promotion Fund, Box 2480, Damacus, Syria.

Gani, M. H., director, Dawood Cotton Mills, Ltd., Landhi, nr. Karachi 22, Pakistan.

Güz, Hüsameddin, civil engineer, Christani & Nielsen, Ltd., Izmir Cod 11/3-Y.S., Ankara, Turkey. For mail: Bilge Sk 5/4 Y.S., Ankara, Turkey.

Instituto Nacional de Vivienda Y Urbanismo, Rodrigo Vargas, engineer, Planes y Obras Dept., Box 2534 San José, Costa Rica.

Laboratorio de Ensaios de Materiais e Melanica do Solo, M. Pimentel dos Santos, chief engineer, C. P. 268, Lourenco Marques, Portuguese East Africa.

Laneuville, J., chief chemist, St. Lawrence Cement Co., Box 1156, Quebec, P. Q., Canada.

Salgueiro, Antonio Luiz, director-president, "Acos Solar Ferragens S/A," rua Pedro Alves, 13/17, Rio de Janeiro, Brazil.

Trouchu, Henri, Chief chemist, Industrial and Commercial Laboratories, 1449 Crescent St., Montreal, P. Q., Canada.

Visser, H. S., laboratory coordinator, N. V. de Bataafsche Petroleum Mij., CSC Secr. Badhuisweg 3, Postbus 3003, Amsterdam-Noord, The Netherlands.

DEATHS . . .

Oscar L. Maag, consulting engineer, Timken Roller Bearing Co., Canton, Ohio, and The Ironside Co., Columbus, Ohio; formerly chief chemist, Timken Roller Bearing Co. (August 23, 1956). A member of the Society since 1936, Mr. Maag had been very active for the past 20 years in the work of Committee D-2 on Petroleum Products and Lubricants and many of the subgroups including Technical Committee G on Lubricating Grease and Technical Committee K on Cutting Fluids. He was chairman of Committee D-2 from 1949 until 1955, also headed Technical Committee K for a number of years. Although ill in 1954 Mr. Maag apparently had recovered good health, and his sudden passing came as a great shock to his committee associates. His gentle manner, kindness, and dry humor endeared him to the many members of Committee D-2 who were privileged to know him.

Henry A. Saller, assistant technical director, Battelle Memorial Institute, Columbus, Ohio (August 14, 1956). One of the country's leading authorities on materials used in the construction of atomic reactors, Mr. Saller died suddenly following attendance at an afternoon conference called by the Atomic Energy Commission in Pittsburgh. He joined the Battelle staff in 1941, and just recently had been named an assistant technical director. He first achieved prominence in the AEC program of atomic energy when he served as a consultant in the fabrication of the first 50 tons of uranium for the prototype of the reactors at Hanford, Wash. Active in many technical groups, Mr. Saller some months ago had become a member of the recently formed Subcommittee XIII on Specifications for Nuclear Rector Structural Materials of ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys.

William Henry Whitcomb, retired textile chemist and instructor in chemistry, 41 Norman Ave., Cranston, R. I. (August 8, 1956). His Society membership dating from 1926, Mr. Whitcomb had been very active for virtually the entire period in Committee D-13 on Textile Materials. He was chairman of the group for two years, and rendered faithful service as secretary for over a quarter-century. In 1951 Mr. Whitcomb had been honored with an ASTM Award of Merit recognizing "his efficient handling of the work of Committee D-13, the editing of its standards, and stimulation of activities which brought the committee and the Society an outstanding reputation for technical achievement in the textile world." A graduate of Massachusetts Institute of Technology, he successively was an instructor at MIT and the University of Miami; was affiliated with U. S. Rubber Co., Henry L. Scott Co., and the Interlaken Mills; and was a member of the faculty of the Rhode Island School of Design.

Karl D. Williams, U. S. Navy, Bureau of Ships, Washington, D. C. (September 4, 1956). For the past 15 years Mr. Williams had represented the U. S. Navy Bureau of Ships on a number of ASTM technical groups, including Committees A-1 on Steel, A-5 on Corrosion of Iron and Steel, B-8 on Electrodeposited Metallic Coatings, C-19 on Structural Sandwich Constructions, and D-13 on Textile Materials. He also served a term of three years on the Administrative Committee on Simulated Service Testing.

NEWS NOTES ON

Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The society is not responsible for statements advanced in this publication.

NEW PRODUCTS

Magnetostriction Transducer—Designed for large scale ultrasonic cleaning, degreasing, descaling, plating, and other metalworking and finishing operations.
Acoustica Associates, Inc. 1208

Lubricant-Friction-Wear Testing Machine—New machine to be known as Model LFW-1, has been developed primarily for testing bonded coatings, a lubrication technique which is finding broad use in all types of industrial applications. It can also be used for testing liquid lubricants.
The Alpha Molykote Corp. 1209

pH Meter—Pocket-size pH meter simplifies pH determinations and provides a new tool for simple and inexpensive pH control.
Analytical Measurements, Inc. 1210

Torque Motor—New unit featuring fast response and high output force. It weighs 11½ ounces and has an output rated at 8 lb of force for 3 w of input power.
Raymond Atchley, Inc. 1211

Demodulator—Designed to supply regulated current to differential transformers (ATC series 6208 M ATCOTRANS) and convert their output to dc for use with micrometers and d-c recording potentiometers.
Automatic Temperature Control Co. 1212

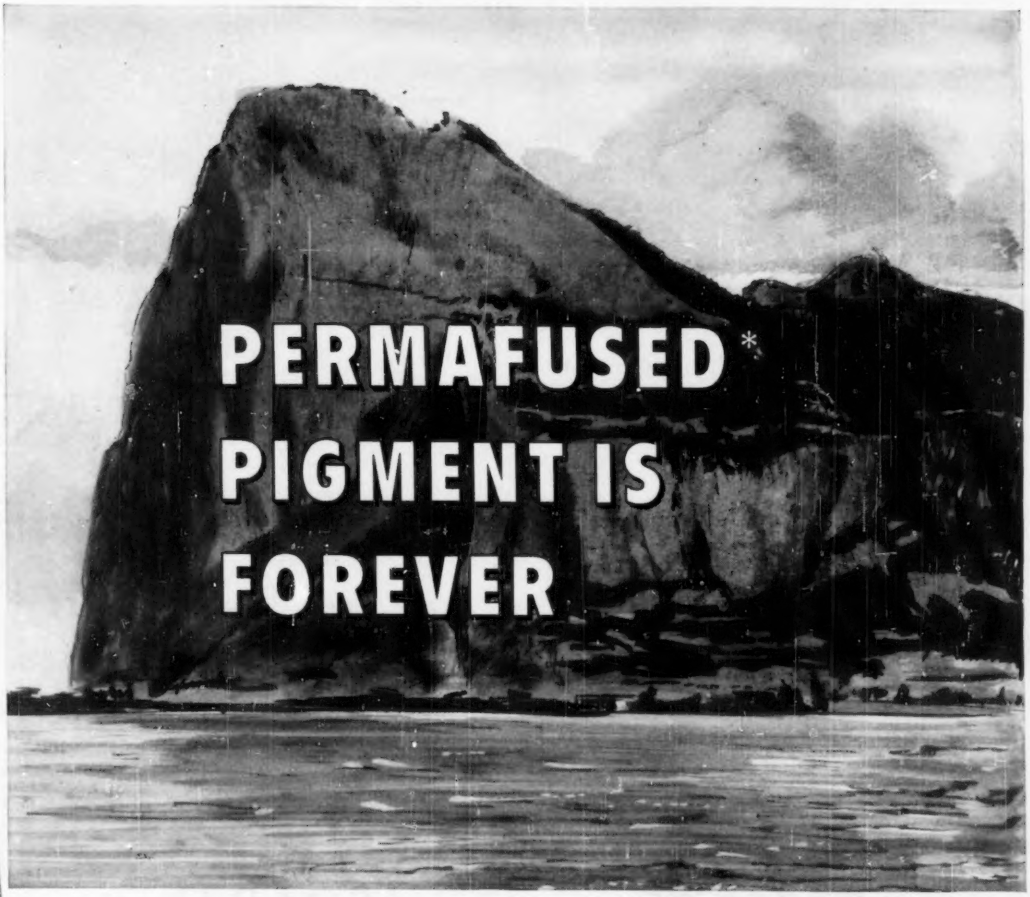
Vertical Scale Indicator—Designed to provide a compact, easily read instrument with minimum price and adequate performance as important features.
Automatic Temperature Control Co. 1213

Testing Machine—A testing machine for making cold bending tests quickly under loads up to 150,000 lb has been developed. Low carbon steel bars up to 2 in. square or 2 in. in diameter in lengths of 5 in. to 24 in. can be bent in the machine. It also accommodates flats up to 4 in. wide and 1 in. thick in the same lengths.
Baldwin-Lima-Hamilton Corp. 1214

Temp-O-Glass Automatic Glass Annealing Oven—Designed specifically for preheating, stress relieving, and heating treatment in small or large batches of industrial and scientific glassware—Blue M new Temp-O-Glass Automatic Glass Annealing ovens features diagonal forced air circulation and temperature range to 1112 F (600 C)
Blue M Electric Co. 1215

Silicon Rectifier—The availability of a completely new high-power silicon rectifier has been announced. It weighs 5 lb and occupies ¼ cu ft. The unit is rated at 100 amps, 200 v.
Bogue Electric Mfg. Co. 1216

(*Continued on page 90*)



WE'D carve this phrase into the towering cliffs of the Rock of Gibraltar if we listened to our engineers—and if the British would let us—because that's how proud our engineers are of new PERMAFUSED Pigment.

"It's Legibility That Lasts," they tell us. "The markings on our new etched-stem, mercury-filled laboratory thermometers *will last as long as the instruments themselves.*"

"That permanently-permanent PERMAFUSED Pigment is fused *directly into the* glass," they add. "It becomes a part of it!"

Here's what their pride, their pigment and their product mean to you.

- You can read these thermometers as long as there's light!
- No solution you test will affect the markings — not even organic solvents — except acids that destroy the glass itself!
- There's no chance of contaminating test solutions with dissolved pigments!

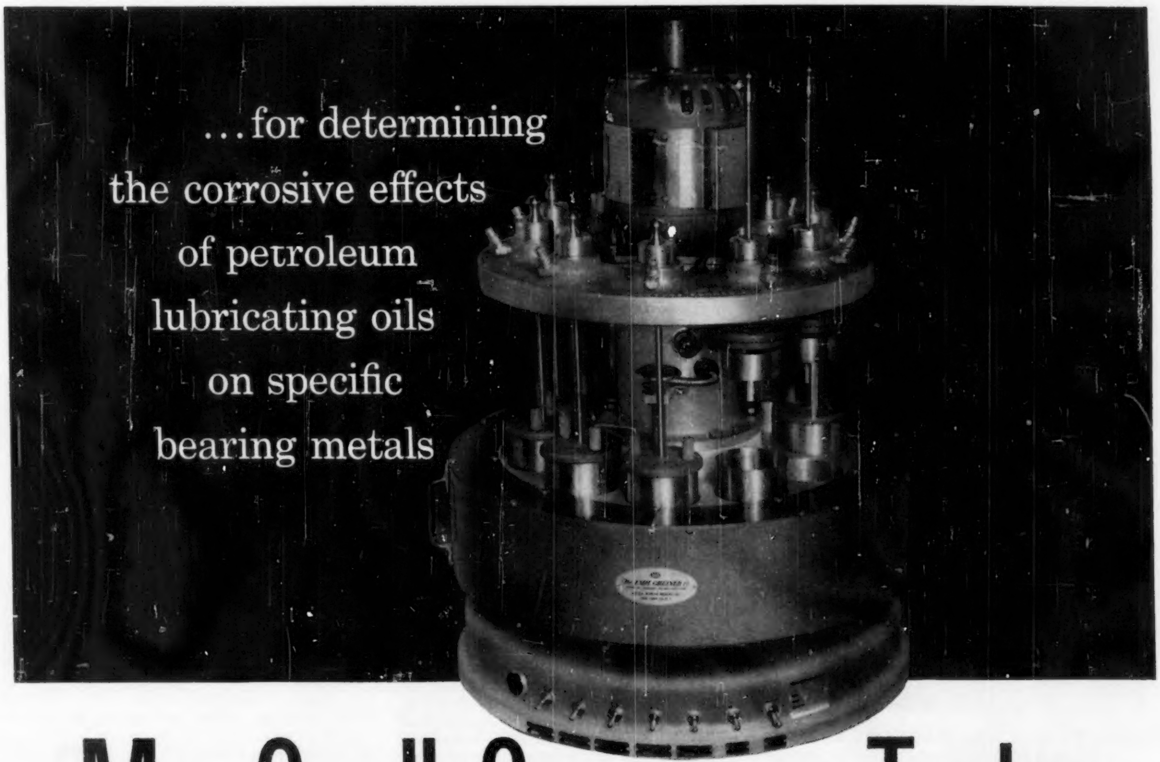
Every Taylor etched thermometer, ASTM, Plain, Armored or Pocket-Type is precision-built and expertly annealed for minimum breakage. The permanent accuracy of the Taylor laboratory thermometer you choose is assured by skilled workmanship and expert ageing before pointing. Taylor thermometers are available with all scales recognized by the Bureau of Standards. Special designs are made to order for specific scientific, research and production purposes.

PERMAFUSED Pigments mean "Legibility That Lasts". For further information on what this can mean to your laboratory, call your Taylor supplier or write for **Catalog LH.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

*Trade Mark

Taylor Instruments **MEAN ACCURACY FIRST**

FOR FURTHER INFORMATION CIRCLE 311 ON READER SERVICE CARD PAGE 105



MacCoull Corrosion Tester

The MacCoull Corrosion Test is a laboratory procedure used for determining the corrosive effects of petroleum lubricating oils on specific bearing metals when the test oil is oxidized in air at an elevated temperature in contact with a catalytic surface. As it is desirable in the MacCoull Corrosion machine to reproduce the conditions which actually exist in an engine, namely, circulation of oil through a rotating bearing, spraying it into the air, contacting a catalytic surface, and recirculating through the bearing, these stipulations were maintained as much as possible in the design of this corrosion test machine.

The apparatus as illustrated is constructed of an aluminum block with ten beaker wells. Cartridge heaters are inserted into the bottom of the block for uniform heat distribution to each beaker well. The lead wires from the cartridge heaters run to a commutator plate between the heating block and the base block which permits rotating the heater block through an arc of approximately 350 degrees. Toggle switches inserted in the aluminum base plate operate the various banks of heaters, to obtain test temperatures of 350° F. In addition a thermoregulator circuit and relay control are also installed in the bottom compartment of the base. The top aluminum deck is equipped with a 1/3 horsepower heavy duty ballbearing motor which drives the ten test spindles through a belt and pulley arrangement. Each individual spinner is equipped with a ballbearing race and operates at a speed of 3000 RPM.

The assembly as illustrated comes complete with ten spinner assemblies, stationary baffle plates, split micarta bushings, stainless steel beakers, splash guard and beaker covers. Suitable for operation on 115 volts, 60 cycles single phase A.C.; current capacity 26 amp. Other voltages and frequencies to special order.

PRICE LIST

G18730	MacCoull corrosion test apparatus complete as described above . **each**	**$2,750.00**
Accessory parts:		
G18731	Spinner assembly including spinner cover and spindle .... **each**	**65.00**
G18732	Bushing, split micarta.... **each**	**4.75**
G18733	Stationary base plate complete with copper baffles .... **each**	**37.50**
G18734	Micarta beaker cover complete with splash guard and chimneys . **each**	**22.50**
G18735	Test bearings copper lead structure **each .25 per 100**	**22.50**

We are also prepared to furnish the above apparatus with the MacCoull-Ryder modification (Pratt & Whitney Design) which incorporates a one piece spinner, stainless steel beaker with the stationary spindle machined as an integral part of the beaker. Price on request.

Send for "Labitems" describing MacCoull Corrosion Tester and other new petroleum testing instruments.

20-26 N. MOORE STREET • DEPT. 229, N. Y. 13, N. Y. E&Co® *The EMIL GREINER Co.*

CIRCLE 315 ON READER SERVICE CARD PAGE 105

New Products

(Continued from page 86)

Signal Generator and Control System—Designed for a wide range of audio frequency measurements with particular emphasis on facilities for automatic frequency scanning and chart recording of data.
Brush Electronics Co. 1217

Pulse Generator—Type 1050, a stable source of usable pulses necessary in the application of digital techniques through a pulse control system, has been developed.
Burroughs Corp. 1218

Vacuum Gauge—New, single-station Pirani vacuum gauge is stated to give direct, continuous pressure readings from 1 to 2000 microns Hg. It measures total pressure of condensable vapors and permanent gases in a vacuum system.
Consolidated Electrodynamics Corp. 1219

Digital Read-Out Micrometer—Micrometer eliminates the source of human error in precision measurements—the mental interpretation of a dial or scale position into the digits of a decimal dimension.
J. W. Dice Co. 1220

Impulse Generator—is designed to produce pulses of fractional millimicrosecond duration, obtained by discharging a coaxial line into a load impedance through a pair of discharge contacts. Pulse duration is determined by the length of the charged line.
Empire Devices Products Corp. 1221

Impressor—A portable hardness tester for aluminum, aluminum alloys, copper, brass, and other materials including plastics. The instrument has been designed for use on fabricated parts and assemblies as well as on raw stock.
Gardner Laboratory, Inc. 1222

Rate Gyro—Incorporates a nonheated temperature-sensitive mechanism claimed to maintain a linear damping over the ambient temperature range of −54 to +71 C, the Model 36129 has a precision potentiometer pickoff.
G. M. Giannini & Co., Inc. 1223

Profile Projector and Comparator—Equipped to provide simple, fast, and accurate optical inspection of machined parts, tools, gears, forms, lamp filaments, and innumerable other objects.
William J. Hacker & Co., Inc. 1224

Thermal Conductivity Gauge — New type of thermal conductivity measuring instrument has been announced. Based on the compensated thermopile principle, it claims accurate measurements to be made without the instability and temperature effects.
Hastings-Raydist, Inc. 1225

New Camera—Alpa-Macrostat copying and close-up stand is now available from Alpa Dealers. The Macrostat has flexible applications in copying prints, posters, or pages; in reproducing small objects like stamps, coins, or gems to exact scale.
Karl Heitz, Inc. 1226

(Continued on page 92)

Mettler

BALANCES

ARE TRULY MODERN

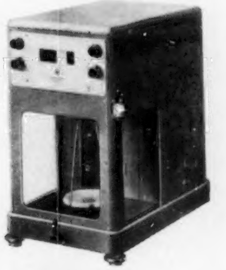
THEY HAVE SPEED, HIGH PRECISION, AND...

YOU CAN RELY ON WHAT YOU CAN READ

THE ANALYTICAL MODELS*

up to 5 weighings per minute

TYPE NO.	CAPACITY	SENSIBILITY RECIPROCAL	READABILITY	PRECISION
FW-5	5000 g	10 mg per scale division	½ of vernier division (0.5 mg)	± 1 mg
B-5 C1000	1000 g	1 mg per scale division	½ of vernier division (0.05 mg)	± 0.1 mg
B-5 C600	600 g	1 mg per scale division	½ of vernier division (0.05 mg)	± 0.1 mg
B-5	200 g	1 mg per scale division	½ of vernier division (0.05 mg)	± 0.05 mg
B-6	100 g	0.05 mg per division of optical micrometer	⅕ of division of optical micrometer (0.01 mg)	± 0.02 mg
M-5	20 g	0.005 mg per division of optical micrometer	⅕ of division of optical micrometer (0.001 mg)	± 0.002 mg



TYPE NO.
B-5

THE HIGH-SPEED PRECISION MODELS*

from 12 to 20 weighings per minute

TYPE NO.	CAPACITY	SENSIBILITY RECIPROCAL	READABILITY	PRECISION
K-4	4000 g	1 g per scale division	⅕ of scale division (0.2 g)	± 0.3 g
K-5	2000 g	1 g per scale division	⅕ of scale division (0.2 g)	± 0.2 g
K-7	800 g	0.1 g per scale division	⅕ of scale division (0.02 g)	± 0.03 g

TYPE NO.
K-5

* Write us today for the complete file on METTLER balances. Ask us to arrange for a demonstration of the balance in your own laboratory.

METTLER INSTRUMENT CORP. HIGHTSTOWN N.J.

CIRCLE 318 ON READER SERVICE CARD PAGE 105

New Products

(*Continued from page 90*)

All Purpose Bench Tester—All Purpose Bench Tester has an operating temperature range of +40 F to −15 F.
Hudson Bay Co. 1227

Scanning Spectrometer—It is claimed to result in a first order reciprocal linear dispersion of 16 Å per mm at the exit slit, with a minimum resolution of 0.2 Å.
Jarrell-Ash Co. 1228

Megacycle—One megacycle frequency standard has two separate outputs, one sine wave, the other, a pulse output with sufficient harmonic content to permit frequency checks to 20 megacycles.
James Knights Co. 1229

Magnetic Field Meter—The new Magnatest Precision Magnetic Field and Magnatest Coercive Force meters are available for the first time. The Magnatest FM-200 (Precision Magnetic Field Meter) is a precise instrument for measuring static D-C magnetic fields as small as 0.01 millioersted.
Magnaflux Corp. 1230

Scintillation Detector—Designed for the measurement of gamma-emitting radioactive samples. It features a large sodium iodide "well" crystal which accommodates a test tube or centrifuge tube containing the radioactive sample.
Nuclear-Instrument & Chemical Corp. 1231

Portable Soil Consolidation Tester—Loads equivalent to 36 tons per square foot on a 2½-in. diameter sample can be applied instantaneously with the new portable physical soil testing machine.
Tinius Olsen Testing Machine Co. 1232

Handi-Mat—Solid polyethylene laboratory bench top protectors are now available. They come in three sizes; the largest is 15 ft by 30 in.
Palo Laboratory Supplies, Inc. 1233

Submerged Specimen Cutter — "Sub-cut"—the laboratory metallurgical cutter is specifically designed to cut under water. By utilizing a slow-speed wheel and rigidly holding the submerged sample in proper position, a perfect cut-off is claimed.
Precision Scientific Co. 1234

Specific-Gravity Test Apparatus—Rapid specific-gravity measurements in the laboratory are made without the technician's hands coming in contact with the fluid, by use of the new Royco Graviometer. This patented device has particular usefulness in the measurement of acids, spirits, urine, etc.
Royco Instruments. 1235

Power Borer—Useful for laboratory boring of corks, stoppers, and metal parts.
E. H. Sargent & Co. 1236

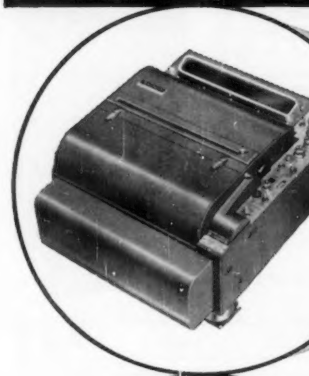
Press Fit—Miniature contact sockets take 0.080-in. test probes. They are available in three different probe sizes: 0.040, 0.050 and the new 0.080 in.
Sealectro Corp. 1237

Lapping Machine—Featuring an 18 in. diam lapping plate, the Spitfire Model No. 18 is designed as a versatile flat lapping machine capable of producing microinch finishing for both small and medium size piece parts such as gauges, sliding and

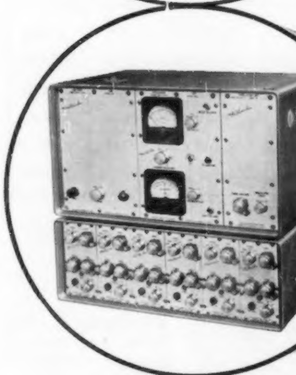
(*Continued on page 94*)

the *Heiland* dynamic recording system gives you more...

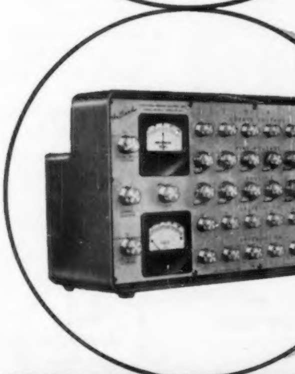
- VERSATILITY
- PERFORMANCE
- EASE OF OPERATION
- FOR RELAY RACK OR TABLE MOUNT



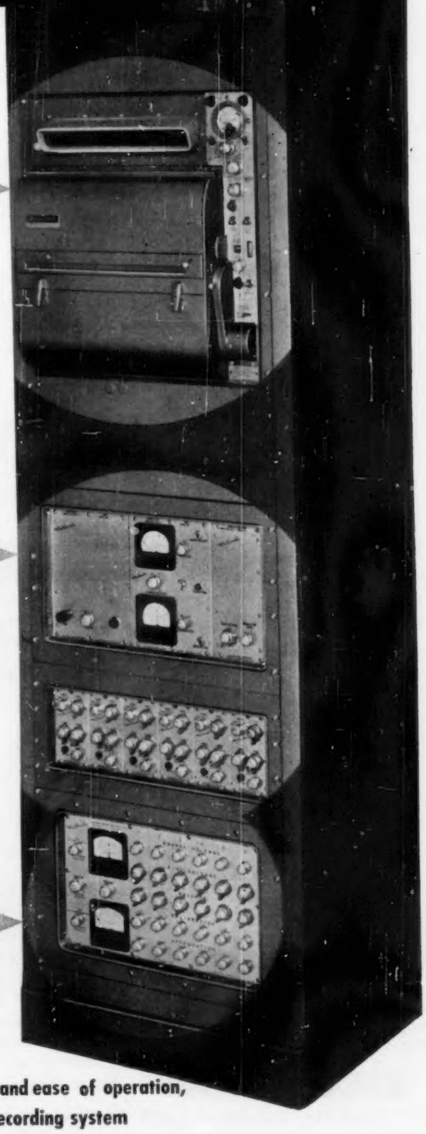
The Series 700 oscillographs feature 8" paper width with 1-36 channels, or 12" paper width with 1-60 channels. Available for 28 v.d.c. or 115 v.a.c. operation, the 700 Series has paper speeds adjustable from .030 to 144"/sec., and writing speeds in excess of 20,000"/sec. Separate supply and take-up drums are light-weight—and light tight for easy daylight loading.



The Heiland 119 Amplifier System offers up to 6 channels, in any combination, of either linear-integrate amplifiers or carrier amplifiers. Carrier amplifier channels provide linear frequency response from 0 to 1000 CPS, for resistive, linear differential transformer, or variable reluctance type transducer inputs. Linear-integrate amplifier channels provide linear frequency response from 5 to 3000 CPS for self-generating transducers. Provides high-amplitude recording up to 8" peak to peak deflection.



The Heiland 82-6 Bridge Balance and Strain Indicator Unit provides a simple and accurate means of balancing, calibrating and measuring static and dynamic phenomena from resistive-type transducers where you don't need amplification. When used as a strain-indicating device without an oscillograph, an input of 25 microamperes produces full scale on the indicating meter.



For versatility, performance, and ease of operation, choose the Heiland dynamic recording system

For details and specifications, write for Bulletin 701-RN

MINNEAPOLIS **Honeywell**

Heiland INSTRUMENTS

HEILAND DIVISION OF MINNEAPOLIS HONEYWELL
5200 E. EVANS AVE., DENVER 22, COLO.

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(Continued from page 92)

rotating parts, air and liquid tight seals, valves, and many other parts requiring precise lapping.
Spitfire Tool Co. 1238

Plexiglass Dry-Dust Box—New milled Plexiglass Dry-Dust Box holds relative humidity to less than 2 per cent and gives the operator complete freedom and comfort plus an excellent visibility.
Triangle Equipment Co., Inc. 1239

Varian Tube—A miniature backward wave oscillator combines low power requirements, small, compact size, and light weight with rugged construction. Designed for modern, miniaturized equipment, the new Varian tube is instantaneously tuned by changing voltage.
Varian Associates. 1240

Rectifier—A higher reverse voltage rating per cell stamped from a new, thinner base material has a reverse voltage rating of 33 v rms and is approximately 20 per cent thinner than the previous cell.
Westinghouse Air Brake Co. 1241

CATALOGS AND LITERATURE

Cup Sink Drain—A corrosion-resistant polyethylene cup sink drain having a $\frac{5}{16}$ in. wall thickness for maximum rigidity and long service life has been announced for laboratory use.
American Agile Corp. 2120

Beryllium Copper—Technical *data sheet No. A-300* contains numerous tables and graphs describing beryllium copper.
American Silver Co. 2121

Technical Data Sheet—Six-page illustrated data sheet contains complete engineering data on a new thermostat bimetal. It contains such items as engineering specifications, formulas for thermal deflections, and load of force.
American Silver Co. 2122

High Temperature Tubing—Engineers and others involved in the design and operation of heat transfer equipment using tubing at elevated pressures will be interested in the data contained in a four-page technical folder, *TDC-142A*.
Babcock & Wilcox Co. 2123

Extrusions—Six-page folder *No. TB-413*, describes the facilities for production of tubular and solid shapes and by means of diagrams explained the Ugine-Sejournet hot extrusion process.
Babcock & Wilcox Co. 2124

Beryllium Copper Alloy—New 4-page bulletin describes the physical properties which make this alloy particularly suited for applications in the electrical and electronic fields—including these design fac-

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tors: (1) high electrical conductivity (45 per cent IACS, minimum); (2) service temperatures of 400 F and above; (3) excellent spring characteristics; and (4) corrosion resistance.
The Beryllium Corp. 2125

B & P Specializes in the Unusual—eight-page folder describes fabricating problems and their solution. Work with magnesium, aluminum, titanium, zirconium, boral, and plexiglas are discussed.
Brooks & Perkins, Inc. 2126

Safe Feeds and Speeds Chart—New Safe Feeds and Speeds Chart for High Speed Drills for use in cast iron, bronze or brass and drop forgings, alloy steel, and tool steel annealed.
Chicago-Latrobe. 2127

Metals—*Bulletin No. 13* describes standards for alloys, minerals, ores, and scrap. Price list included.
Crippen & Erlich Laboratories, Inc. 2128

Glass Data Sheets—Two data sheets in a continuing series on laboratory glassware have been released. A file folder, to be used in maintaining the data sheet series intact, is supplied.
Doerr Glass Co. 2129

Services and Facilities—72-page Bulletin outlines services and facilities of leading independent test laboratory. It covers chemical, electrical, electronic, mechanical and physical, and photometric, radiometric and colorimetric testing. Also describes spectroscopy, photomicrography, environmental, near infrared and ultraviolet facilities.
Electrical Testing Laboratories, Inc. 2130

Saybolt Viscosimeter—*Bulletin FS-261* describes a four tube instrument with an illuminated background.
Fisher Scientific Co. 2131

Recorder—*Bulletin No. 167* describes the Gardner Automatic Gloss, Color and Reflectance Recorder which utilizes a modified Varian Model G-10 Graphic Recording Unit.
Gardner Laboratory, Inc. 2132

New Data Booklet—A fully illustrated booklet entitled, *Some Properties of Inco Nickel Alloys at Low Temperatures*, has been issued recently. The bulletin describes the various wrought and cast high-nickel alloys used at low temperatures.
International Nickel Co., Inc. 2133

Freeze-Drying Equipment—36-page catalog includes descriptions of new freeze-drying units, vacuum gauges and pumps, bath coolers, refrigerated centrifuges, and related laboratory and small-scale production equipment.
Arthur S. LaPine & Co. 2134

Rectangular-Shaped Motors—Catalog sheet, illustrating and describing rectangular-shaped motors, has been released. The literature is illustrated with both photographs and engineering drawings; detailed specifications; operating information and representative performance data.
Leece-Neville Co. 2135

Adjustable D-C Resistors—New two-page *Data Sheet EB2* describing adjustable d-c resistors is now available.
Leeds & Northrup Co. 2136

Microwave and UHF Test Equipment—28-page catalog covers a complete line of coaxial and UHF equipment, microwave test equipment, and bolometers and thermistors. Test, specification tables, and photographs describe existing equipment and such recent additions as fixed and variable attenuators, high power impedance meters, tees, fixed and sliding terminations, and UFH coaxial directional couplers.
The Narda Corp. 2137

Monitor—Two-page specification sheet describes the Model 2715 "Nemo" a portable battery-operated survey meter for the measurement of thermal and fast neutron fluxes from 10 to 10^4 neutrons per cm^2 per second.
Nuclear Instrument and Chemical Corp. 2138

Catalog Digest—Describes the Panoramic instruments that are designed for applications requiring accurate high speed spectrum or waveform analysis.
Panoramic Radio Products, Inc. 2140

Fineness Tester—*Bulletin 233* describes the Precision-Blaine Air Permeability Fineness Tester for determining the fineness of Portland Cement (in accordance with ASTM C 204), pharmaceutical powders and other granular materials.
Precision Scientific Co. 2141

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Reynolds Aluminum Digest—A compact monthly publication covering aluminum news is being made available to the metalworking industry.
Reynolds Metal Co. 2142

Lab-Oratory—A Chromatograph Scanner is one of many new items featured in the latest issue. Included also are: micropipet washer and drier, rotating vacuum type evaporators, and thermo-circulator ovens.
Schaar & Co. 2143

1956 Soiltest Catalog—Contains descriptions and illustrations of over 1350 items of apparatus for engineering tests of soils, concrete asphalt, and construction materials. Included are suggested laboratory layouts with equipment lists and excerpts from ASTM and AASHO specifications.
Soiltest Inc. 2144

Transrecorder—Univac's MTM transrecorder and PTM and MTP converters are detailed in a 10-page folder recently issued. All three units deal with the use of tape to transmit data for the various Univac systems.
Sperry Rand Corp. 2145

Variable Resistors—Folder describes variable single and multistage resistors.
Stackpole Carbon Co. 2146

TR Chamber—Four-page folder discusses the Tenney TR chamber especially designed for accurate controlled low-high-temperature and relative humidity testing.
Tenney Engineering, Inc. 2147

Catalog No. 56—A catalog of resistance welding products, accessories, and materials was made available recently. This literature describes and specifies standard and special spot welding electrode, seam welding electrode wheels, dies, back-up bars, shafts, and bushings. In addition, illustrated and specified in this catalog are Weldaloy water-cooled electrode holders, adapters, horn-clamp-holder assemblies, and other accessories.
Weldaloy Products Co. 2148

INSTRUMENT COMPANY NEWS

A-P Controls Corp., Milwaukee, Wis.—Announcement was made that Remy Ludwig has been appointed vice-president of the International Division of Controls Co. of America. Mr. Ludwig will supervise all administrative duties and management of the company's foreign plants.

Gardner Laboratory, Inc., Bethesda, Md.—Gardner Laboratory recently occupied its new quarters at 5521 Landy Lane, Bethesda, Md. The new headquarters provide 15,500 sq ft of floor space. Complete facilities for manufacture of physical testing equipment are housed here.

H-B Instrument Co., Phila., Pa.—The Tagliabue laboratory and industrial thermometer and hydrometer division has been purchased from Weston Electrical Instrument Corp. by the H-B Instrument Co. of Philadelphia, Pa. It specializes in the manufacture of scientific instruments utilizing glass and mercury.

Minneapolis-Honeywell Regulator Co., Phila., Pa.—K. Russell Knoblauch has been appointed sales manager for the oil and chemical industries for the eastern region of Minneapolis-Honeywell Regulator Co.'s Industrial Division. He succeeds R. H. Schlegel.

Perkin Engineering Corp., Newark, N. J.—A new regional sales-engineering office to service the New York area has been opened by the Perkin Engineering Corp., El Segundo, Calif., according to Phil Diamond, president. Perkin manufactures d-c power supplies and a-c line voltage regulators. District manager of the new office is Millard Leff.

(Continued on page 102)

Ampex Corp., Redwood City, Calif.—Robert Sackman has been elected vice-president of the Ampex Corp., Redwood City, Calif. Sackman attended George Washington University and is a member of Sigma Tau, the Institute of Radio Engineers, Instrument Society of America, and the American Management Assn.

The Society of the Plastics Industry, Inc., New York.—The formation of a Vinyl Dispersions Division within the framework of the Society of the Plastics Industry, Inc., has just been announced. According to William T. Cruse, executive vice-president of the SPI, the new Vinyl Dispersions Division has been formed to bring about a stable, vinyl dispersions industry; to develop specifications, physical test procedures, and performance standards on vinyl dispersions for eventual adoption by the industry; and to evolve standards covering vinyl dispersions used for both industrial and consumer applications.

Southern Regional Research Laboratory, New Orleans, La.—Two members of the staff of the Southern Regional Research Laboratory, Mrs. E. L. Skau, librarian, and T. H. Hopper, head of the Analytical, Physical-Chemical and Physics Section, were honored in Washington, D. C., recently; they received Superior Service Awards from the U. S. Department of Agriculture for their contributions to research on the utilization of southern farms crops.

Metals for Aerodynamic Applications

THE Albuquerque and Los Alamos Chapters, ASM, and the Extension Division, University of New Mexico will sponsor a timely conference on "Heat Tolerant Metals for Aerodynamic Applications" in Albuquerque on January 28 and 29, 1957. Eleven pertinent papers will be presented by speakers well qualified in this field. Preprints of the papers will be available to advance registrants. J. R. Townsend, Past President and Director of ASTM, will give the conference review, summary, and evaluation.

Corrections

Attention has been called to inaccuracies in the report on the paper by H. T. Arni, B. E. Foster, and R. A. Clevenger, National Bureau of Standards, as published in the July issue of the ASTM BULLETIN, page 20:

The title should read: "Automatic Equipment and Cooperative Test Results for the Four Freezing-and-Thawing Methods for Concrete." The conclusion that significant discrimination between aggregates was obtained only in the freezing-in-air and thawing-in-water method should apply only to nonair-entrained concrete.

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From "Testing Headquarters" comes this new Model FGT 150,000 lb. universal testing machine with all these advantages for *you:*

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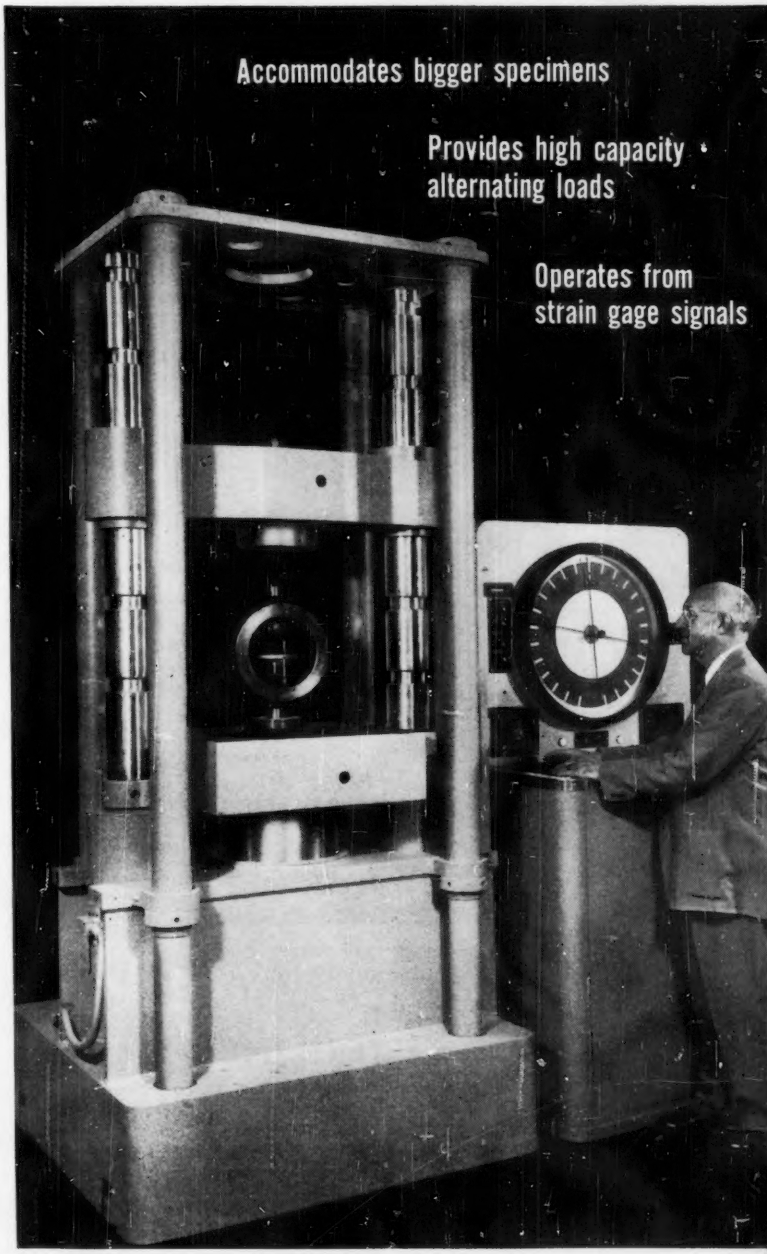
- Machine has greater rigidity (due to stay plates at top) and is more resistant to lateral forces (it's a screw within a piston running in a cylinder which supports it in every direction).
- Equipped with ball bearing screw.
- Provides load cycling without changing position of specimen.
- SR-4 indicating unit has practically instantaneous response.
- Can be operated from strain gage signals to reproduce service conditions in the laboratory. Signals from actual field tests are stored on magnetic tape to control this testing machine automatically.

Loads are measured by Baldwin SR-4 transducers, and output may be fed to printers, converters, typewriters and card punch systems. For full information write Dept. 1093, Electronics & Instrumentation Division, BLH Corporation, Waltham, Massachusetts.



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New Products Section page 86

One sentence descriptions of new testing machines, laboratory or control apparatus, and related equipment.

Catalogs and Literature Section page 94

Charts, data sheets, catalogs, and other printed matter applicable to research, testing, or production control of engineering materials.

October, 1956

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						2148

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